PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION

Improvements in Electric Lighting Control Apparatus

I, ROLLO GILLESPIE WILLIAMS, a British Subject, of Apartment 1Z, 20, Clent Road, Great Neck, Long Island, New York, United States of America, do hereby declare the nature of this invention to be as follows:—

This invention relates to the control of electric lighting circuits when some or all of the circuits controlled have dimmers or some other form of brightness control regulator to vary the intensity of the lighting.

The invention has for one of its objects the provision of lighting control apparatus of a type which will enable predetermined arrangements of lighting circuits to be reproduced at the desired intensities of light as and when required. Also to enable any selected combination of lighting to merge directly into the next selected combination in any desired order.

For example the lighting arrangements for a theatre stage may include a large number of lighting circuits supplying various spotlights, floodlights and trough equipment, many circuits being each controlled by a dimmer or other means to enable the lighting intensity provided by the lighting equipment to be varied to any desired strength between "full light" and "blackout." The number of circuits in use and the lighting intensity provided by the lighting equipment connected thereto may be varied at frequent intervals according to the requirements of the lighting plot.

One of the objects of this invention is to provide means which will enable the lighting requirements to be set up in advance in such a manner that a number of desired preset combinations of dimmers and lighting circuits may be reproduced at any time, irrespective of the order of the changes. The changes from one preset combination to another may take place at any desired speed and the dimmers or brightness regulators (when dimmer changes are involved) will always move directly to the required positions. The apparatus may be constructed for the presetting of a large number of lighting combinations, as for example 60.

Some or all of the lighting controlled may be of a single circuit equipment type giving only one colour of light, in other words the combination of the lighting circuits is not dependent on the need for colour blending, although in practice it may well be that some or all of the lighting circuits may be selected with this end in view. For example a number of the circuits may have single lampbulb spotlights connected thereto and arranged to give white light, while other circuits may control multi-circuit (i.e., multi-colour) equipment in which the circuits correspond with lighting of different colours and are blended to give desired colour lighting effects. In such a case the lighting requirements from time to time in the lighting plot might require variations in the strength of the spotlighting as well as variations in the number of spotlights in use, while at the same time the number and strength of the circuits in the multi-colour lighting equipment would vary according to the need for changes in the colour of the lighting provided thereby.

This invention can also be applied to the control of multi-colour lighting equipment of the kind which is suitable for use in show windows, dance halls, cinematograph theatres, interior lighting etc., and it can be utilised for the reproduction of predetermined colour lighting effects. It can also be utilised for the reproduction of various arrangements of single-colour lighting either alone or in conjunction with colour effects from multi-colour lighting equipment.

Control apparatus according to this invention can be constructed so that any desired number of lighting circuits and/or dimmers (or other convenient form of

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brightness control) can be governed from a single control apparatus, and if desired the whole of the circuits say for a complete stage installation can be determined from a single pre-set indicator with its associated operating mechanism according to this invention. Alternatively it may be preferred to have a number of unit control mechanisms each governing a desired number of the lighting circuits. In the latter case means of collective operation of the various operating mechanisms may be provided.

This invention will also provide means which will enable the overall lighting intensity of all the circuits in use to be varied so that a change in overall intensity is proportional (or very nearly proportional) to their original and relative strengths in each case. Thus if an arrangement of dimmers first included dimmer A at 100%, dimmer B at 80% and dimmer C at 60% of full light, then a reduction of intensity to one half would result in dimmer A at 50%, dimmer B at 40%, and dimmer C at 30% of full light instead of dimmer A at 50%, dimmer B at 30% and dimmer C at 10% of full light, as would be the case if all three dimmers were to each move one half of full travel. Among other things this enables a lighting arrangement to be varied in overall intensity without the various circuits losing their light relationship to each other.

Another object of the invention is to provide means which will enable someone to set up his own requirements for lighting changes and for the changes to be then automatically reproduced in a sequence as desired by him.

Means for experimentation with the lighting controls and dimmers can be provided and they can be operated independently of the present effects, or the preset effects can be modified and/or changed as required.

While the word " dimmer " is used in the following description, it is understood that any convenient form of brightness control may be employed, as for example electronic, auto-transformer, wire wound dimmers etc. The type of dimmer illustrated in the accompanying drawings is a rotary action stud dimmer of the enclosed type. Also the magnetic clutches may be of any convenient design or may be replaced by apparatus which is their electrical equivalent. Furthermore the magnetic clutches or equivalent may be mounted in any convenient relationship to the brightness controls and may for example be mounted on the actual dimmer shafts instead of the hand lever shaft.

The following apparatus is described by way of example, and illustrates one mode of carrying the invention into effect. In this example four dimmers are shown to be operated, but the invention is not limited to any specific number but may be utilised to control as many dimmers as are desired, as for example twelve.

The description which now follows should be read in conjunction with the accompanying drawings in which:

Figure 1 is a plan view of the apparatus with the top removed:

Figure 2 is a side elevation with the side cover removed:

Figure 3 is a front section on the line 3—3:

Figure 4 is a front elevation of compound contact-plate movable member:

Figure 5 is a section of movable contact arm assembly:

Figure 6 is a perspective view of the complete apparatus:

Figure 7 is a diagram showing the electrical circuit between the contact plates and the magnetic clutch coils:

Figure 8 is an alternative construction to Figure 5 above:

Figure 9 is an alternative form of construction for a pair of contact plates:

Figure 10 is a plan view of contact plate assemblies as Figure 9 above, mounted in the movable member.

The apparatus consists of a framework 44 in which are mounted by way of example four rotary stud type totally enclosed dimmers 1*a*, 1*b*, 1*c*, 1*d*. Rotary motion is imparted to these dimmers by some convenient means, in this case a rack and pinion for each dimmer (2*a*—3*a*, 2*b*—3*b*, 2*c*—3*c*, 2*d*—3*d*) connected by link rods 4*a*, 4*b*, 4*c*, 4*d*, to hand operated levers 5*a*, 5*b* 5*c*, 5*d*, mounted on the shaft 6. Individual hand operation of the dimmers can be obtained by manipulation of the handles 14*a*, 14*b*, 14*c*, 14*d*, fixed at the ends of the levers 5*a*, 5*b*, 5*c*, 5*d*.

The levers 5*a*, 5*b*, 5*c*, 5*d* are loosely mounted on the shaft 6, and each lever carries two electro-magnets (12*a* and 13*a*, 12*b* and 13*b*, 12*c* and 13*c*, 12*d* and 13*d*) with the projecting part of the iron cores facing in opposite directions, so that electro-magnet 12*a* for example will attach itself to the iron plate fastened to the inside face of the bevel wheel 7*a*, when energised; while magnet 13*a* will attach itself to the iron plate inside bevel wheel 6*a*, when energised. While there is a slight gap between the magnet cores and the iron plates when both coils are de-energised, by providing a small amount of play between the levers 5*a*, 5*b*, 5*c*, 5*d* and the shaft 6, either magnet can pull its mounting lever over slightly when energised so as to attach itself to the iron plate adja-

cent to it.

The levers and magnet coils just described are mounted so that each lever comes between a pair of bevel wheels 6*a* and 7*a*, 6*b* and 7*b*, 6*c* and 7*c*, 6*d* and 7*d*. One wheel of each pair, in this case 6*a*, 6*b*, 6*c*, 6*d* is fastened to the shaft 6 by means of screws 9*a*, 9*b*, 9*c*, 9*d*, while the other wheel of each pair is loosely mounted on this shaft but is prevented from moving sideways by pins 10*a*, 10*b*, 10*c*, 10*d*, which locate in corresponding grooves in the shaft 6. Each pair of bevel wheels, however, are linked by a third bevel wheel 8*a*, 8*b*, 8*c*, 8*d*, so that motion can be imparted to the loosely mounted wheels 7*a*, 7*b*, 7*c*, 7*d*, if the shaft 6 to which are fastened the bevel wheels 6*a*, 6*b*, 6*c*, 6*d*, is rotated. The loosely mounted bevel wheels 7*a*, 7*b*, 7*c*, 7*d*, however, will rotate in the opposite direction to that of the shaft 6 and the wheels 6*a*, 6*b*, 6*c*, 6*d*.

If the shaft 6 is rotated in one direction only, the levers 5*a*, 5*b*, 5*c*, 5*d*, will move in the same direction as the shaft if the magnet coils 13*a*, 13*b*, 13*c*, 13*d*, are energised but will move in the opposite direction if the magnets 12*a*, 12*b*, 12*c*, 12*d* are energised.

It will be seen from Figure 7 that each pair of electro-magnets are electrically connected to a pair of contact plates. Thus magnet 12*a* is connected to contact plate 16*a* and magnet 13*a* is connected to contact plate 15*a*; magnet 12*b* to plate 16*b* and magnet 13*b* to plate 15*b*, etc. The four pairs of contact plates 15*a*—16*a*, 15*b*—16*b*, 15*c*—16*c*, 15*d*—16*d* are shown in Figure 4 mounted upon a common base 18, and are seen again in section mounted upon their base in Figure 2. It will be seen from Figure 4 that there is a gap between each pair of contact plates, the four gaps being shown at 17*a*, 17*b*, 17*c*, 17*d*. The base 18 upon which the four pairs of contact plates are mounted is made of insulating material, or alternatively other means are taken to insulate the various contact plates from each other.

Electricity is supplied to either contact plate of each pair, by means of a contact arm. Figure 5 shows a contact arm assembly in which a contact brush 26*a* is held in a holder 23*a* and pressed against the contact plate assembly by means of a spring 27*a*. Since there are four pairs of contact plates there are four contact arm assemblies and these are shown in Figure 2. It will be seen that the brush-holders 23*a*, 23*b*, 23*c*, 23*d* are pivoted at 22*a*, 22*b*, 22*c*, 22*d* between the upright supports 24*a* and 24*b*. These brush-holders have lever arms 21*a*, 21*b*, 21*c*, 21*d* attached to them so that movement of these levers will cause a corresponding movement of the brush-holders and the contact brushes 26*a*, 26*b*, 26*c*, 26*d*, and the latter will be able to move over the surface of the contact plates adjacent to them.

The lever arms 21*a*, 21*b*, 21*c*, 21*d* are shaped to terminate at different positions on plan as will be seen from Figure 4 and the opposite ends to the brush-holder end of these levers are spaced out at approximately the same distance apart as the distances between the four dimmers 1*a*, 1*b*, 1*c*, 1*d*, so that they can be linked by connecting rods to the link assemblies which in turn connect the dimmers to the levers 5*a*, 5*b*, 5*c*, 5*d*.

Thus the ratchet arm 3*a* which operates the pinion 2*a* on the dimmer 1*a* is connected from a pivot at 20*a* by means of connecting rod 19*a* to the lever 21*a* which is associated with the brush-holder 23*a*. Similarly ratchet 3*b* is connected by rod 19*b* to the lever arm 21*b* which operates brush-holder 23*b*; ratchet 3*c* by means of rod 19*c* to lever arm 21*c* and brush-holder 23*c*; and ratchet 3*d* by means of rod 19*d* to lever arm 21*d* and brush-holder 23*d*. Thus movement of the dimmer 1*a* will cause the contact brush 26*a* in the brush-holder 23*a* to move in accord with the dimmer. Similarly the dimmer 1*b* will cause a corresponding movement of contact brush 26*b*; dimmer 1*c* a movement of contact brush 26*c*. and dimmer 1*d* a corresponding movement of contact brush 26*d*.

If no electricity is flowing from the contact brushes to the electro-magnets 12*a*, 12*b*, 12*c*, 12*d* and 13*a*, 13*b*, 13*c*, 13*d*, then the dimmers can be moved freely by hand by means of the handles 14*a*, 14*b*, 14*c*, 14*d*, and the contact brushes 26*a*, 26*b*, 26*c*, 26*d* will move over their corresponding pairs of contact plates 15*a*—16*a*, 15*b*—16*b*, 15*c*—16*c*, 15*d*—16*d*, without anything happening as the result of these contacts. To permit this free movement when the apparatus is in normal use, the supply of electricity is broken by some convenient switch or switches, in the example under consideration there being a switch of the press-button type at the end of each dimmer operating handle as shown at 47*a*, 47*b*, 47*c*, 47*d*. Thus pressure of the button 47*a* by the thumb will break the supply of electricity to the electro-magnets associated with the handle 14*a* and allow the dimmer 1*a* to be freely adjusted by hand. This is further shown in Figure 7 where the switches are shown as breaking the return feed from the electro-magnet coils.

When current is flowing through the contact plate circuits however the effect will be to energise one of the two electro-magnet coils in each set, unless the contact brush happens to rest in the gap be-

tween a pair of contact plates, in which case that particular circuit will of course be broken. Energisation of one of the magnet coils will not of itself cause any change in the position of its associated dimmer but should the shaft 6 now be rotated by means of the handwheel 43 then the dimmer in question will now move either up or down, according to which of the side iron plates of each set of bevel wheels is gripped by an electro-magnet.

The shaft 6 is arranged for rotation in one direction only, and this is arranged so that whether the dimmer is going up or down, the contact brush assembly which moves in accord with it always moves towards the gap between the two contact plates. As soon as the brush reaches this gap the supply of electricity to the magnet coils associated with these contact plates is broken and the dimmer ceases to move in conjunction with the shaft 6.

Thus in Figure 5 the contact brush 26*a* is shown in contact with the lower plate 16*a* and the effect of this will be to energise the coil 12*a* which will cause the dimmer to increase in brightness when the shaft 6 is rotated and at the same time cause the contact brush 26*a* to also move in an upward direction towards the gap 17*a*. As soon as the brush reaches this gap it will break the supply of electricity to either contact plate 15*a* or 16*a* and the dimmer will remain stationary and cease to move in accord with the rotation of shaft 6. Alternatively had the contact brush 26*a* been touching contact plate 15*a* then the other magnet coil in the set, i.e., 18*a* would have been energised with the result that the dimmer would have moved in the opposite direction and the contact brush 26*a* would have moved downwards towards the gap 17*a*.

The position of the gap between the two contact plates of each set therefore determines the stopping position of each dimmer. It will be seen from Figure 4 that the position of the gap between each pair of contact plates varies along the length of the plates. Furthermore, that the position of the gap between any one pair of contact plates varies at any given point along the length of the plates relative to one or more of the other sets of plates. Thus in Figure 4 the four contact brushes 26*a*, 26*b*, 26*c*, 26*d* are shown at a position in the middle of the length of the four pairs of contact plates, and in each case the brush is in contact with the lower plate of each pair, thus energising magnets 12*a*, 12*b*, 12*c*, 12*d* and causing all four dimmers to increase in brightness when the shaft 6 is rotated. The four contact brushes will at the same time move in an upward direction until each brush reaches a gap between the contact plates and both dimmers and brushes will remain stationary.

The base 18 upon which the four pairs of contact plates are mounted, is however slidably mounted in a frame 29 and can be moved in either direction at right angles to the arc of travel of the contact brushes. Thus in Figure 4 it will be seen that the base 18 can move either to the left or the right of the position shown. This movement is achieved by means of a rack and pinion 33 and 32 in the constructon under consideration but any suitable means can be employed. For example in some constructions it might be desirable to cause the desired movement of the base 18 to take place as the result of turning a wheel or knob or by moving a lever located further away from or even at a distance from the base 18 in question.

Movement of the base 18 to a new position relative to the contact brushes 26*a*, 26*b*, 26*c*, 26*d*, will enable the gap between any pair of contact plates to be located in a new position relative to the path of travel of the associated contact brush, and the dimmer concerned will be given a new stopping position in accord with the position of the gap.

It will be seen that since all four sets of contact plates are mounted on the same base, they are moved as one unit when the base in question is moved, and the whole assembly becomes one compound contact-plate movable member. Together with the four movable brush-holders and brushes it forms one compound switch mechanism in which the base is moved as a single member to vary the location of the breaking points of the switch ways. During normal operation of this compound switch mechanism the supply of electricity to it is constant and displacement of part of the switch relative to the other part or parts determines the breaking point of any of the switch ways. That is to say this switch mechanism does not depend upon any external or additional apparatus or means to energise or determine the energisation of the switch ways or to determine the stopping points of these switch ways.

It will be seen that movement of the movable base member of the compound switch mechanism simultaneously affects all the sets of contact plates and each of the dimmers can if desired be given a new stopping position. Thus if the gaps between the contact plates are located beforehand to correspond with the desired position of the dimmers movement of the movable contact plate member to a certain

position will enable all the dimmers to be simultaneously moved to the predetermined positions as and when the shaft 6 is rotated. The dimmers will then directly move to the predetermined positions at a speed corresponding to the speed of rotation of the shaft 6.

In the construction shown in the accompanying drawings the shaft 6 is rotated by means of the hand wheel 43 but any convenient means for turning this shaft may be employed. When a number of separate sets of control apparatus according to this invention are grouped together means may be provided to allow some or all of these shafts to be simultaneously rotated or rotated at different speeds.

While the pairs of contact plates have been so far shown as mounted on a common base 18 so that the relationship of the contact plates to the contact brushes may be simultaneously affected if desired the contact plates may be mounted on a separate base for each pair provided that they move together or can be made to move together as one unit. Means may however be provided to adjust the relationship of any pair of contact plates relative to the other pairs of contact plates.

The contact plates have been shown as mounted on an oblong base which is slidably mounted, but if desired the contact plates may be mounted on the face or periphery of a wheel or drum arranged to rotate or may be mounted in any other convenient manner.

If desired the relationship of the contact plates and the contact brushes may be reversed and an example of this is shown in Figure 8. In this case the brush-holder 23*a* (see Figure 5) instead of carrying the contact brush 26*a* would carry the arm 52*a* which carries at its end a mounting on which are fixed the contact plates 48*a* and 49*a* with the gap between them shown at 50*a*. The plates are now mounted on the movable member and by means of the spring 27*a* in the brush-holder are pressed against a stationary contact strip or studs 51*a* mounted in any desired manner upon a base 53. In this construction the contact 51*a* would be continuously energised with electricity and would energise the electromagnet coils through the contact plates 48*a* and 49*a*.

It has been shown that movement of the movable base member of the compound switch mechanism will enable predetermined combinations of dimmer positions to be reproduced. In Figures 1, 2 and 6 a pointer 36 is shown moving over a scale or name plate so that by turning the knob 35 an operator will be able to move the movable base member to the desired position. Any desired number of stopping positions for preset dimmer arrangements may be embodied in the apparatus as for example forty.

The movable base member of the compound switch mechanism can also be arranged to be moved in another sense so that in addition to change of position as already described it can also be moved nearer to the pivoting points 22*a*, 22*b*, 22*c*, 22*d* of the brush-holders 23*a*, 23*b*, 23*c*, 23*d*. In Figure 4 it will be seen that the frame 29 which carries the slidable contact base 18 is in itself slidably mounted in another frame 38, and can be moved at right angles to the sliding movement of base 18 by means of a rack 41 (see also Figure 2) and pinion 39 which is mounted on a shaft 40 and turned by handwheel 42. Thus this whole switch base assembly can be varied in its distance from the pivoting points described above. This does not affect the movement of the slidable base as the pinion 33 (see Figures 1 and 2) is deep enough to remain in engagement with the rack 32 at all positions of the frame 29.

It will be seen from Figure 5 that when the contact plates 15*a* and 16*a* are moved from position AA to another position BB which is nearer to the pivoting point of the brush-holder 23*a* the contact brush 26*a* is pressed into the brush-holder and will have to move through a greater angle to reach the gap 17*a* unless this gap is located in direct line through the brush and brush-holder. Thus in Figure 5 the arc of travel of the contact brush will be increased from CC to C^1C^1 when the contact plates are at AA to DD to D^1D^1 when the contact plates are at BB in order to reach the gap 17*a*. In as much as the movement of the brush is related to the movement of the dimmer associated with it the dimmer will travel further when the contact brush moves from the horizontal position shown on Figure 5 to the gap 17*a* when this is located on the line BB.

When calculating the positions of the gaps between the contact plates it is arranged that the lowest position of a dimmer shall be reached when the gap is directly in line through the contact brush and holder. To get full light from a dimmer the gap is situated so that the contact brush and arm have to travel through the maximum arc of travel. The maximum arc of travel is only reached when the contact plates are at the shortest distance from the pivoting points of the brush-holders, i.e., in Figure 5 at BB. To get full light from any of the dimmer circuits it is necessary for the movable base member 18 to be at its nearest position to the pivoting points of the brush-holders, i.e., at position BB in Figure 5. The

dimmers will then take up their relative positions as determined by the position of the gaps between the contact plates and the maximum overall lighting intensity will be obtained from the lighting apparatus controlled by the dimmers.

When by movement of the wheel 42 the movable base member 18 is taken further away from the pivoting points of the brush-holders then on the line BB then the dimmers will take up the same relative position to each other but since the contact brushes 26*a*, 26*b*, 26*c*, 26*d* will now move through a smaller arc of travel in order to reach the gaps between the contact plates the dimmers will stop further away from the " full light " positions thus giving a lower overall lighting intensity.

While no difficulties are experienced in causing the dimmer arms in the dimmers to stop short of their extreme " full light " position it is important that at the opposite end of their travel these dimmer arms are not required to go beyond the " full out " position as with most designs of dimmer the arms cannot travel beyond this point. Thus while all the dimmers in a combination can be made to stop further away from the " full light " positions as explained in previous paragraphs, movement of the dimmer arms must always stop when they reach their " full out " positions. This is ensured by arranging that the gap between each pair of contact plates corresponds to the " full out " position of a dimmer when this gap is directly in line with the brush-holder when this is at right angles to the thrust of the contact plate assembly. At this position variation of the distance between the contact plates and the pivoting point of the brush-holder makes no difference to the relative position of the gap and contact brush. It is only when the contact brush is not at right angles that there is a variation in its arc of travel in order to reach a given position of the gap between a pair of contact plates.

According to this invention the dimmers will always stop at the " full out " positions together regardless of their different starting points, assuming that this effect is required. From the foregoing it will be seen also that variation of the distance between the contact plates and the pivoting points of the brush-holders will affect all the dimers in proportion to their relative positions. Thus if the arc of travel is reduced say by 25% for a dimmer at " full light " position, the arc of travel of other dimmers giving various strengths of light will also be reduced by approximately the same amount, so that another dimmer say at one half of full light will have its travel reduced by 25% of one half. Thus the overall intensity of light provided by dimmer circuits at various strengths can be varied without upsetting the proportion of light provided by the different dimmer circuits. If desired the apparatus can be constructed so that dimmers can be caused to move from " full light " to " loss of light " simply as the result of moving the base 18 far enough away from the pivoting points of the brush-holders and then operating the shaft 6.

From the foregoing description of the control apparatus it will be seen that lighting effects can be tried out experimentally by means of the individual dimmer operating handles 14*a*, 14*b*, 14*c*, 14*d*, and when the desired effects are known, contact plates are cut and fitted in the compound switch mechanism. As an alternative to the latter contact strips may be shaped and fitted as indicated at 51*a* in Figure 8, or alternatively contact studs fitted at the required positions at these points. By fitting scales at the side of the dimmer operating handles the corresponding position of the gap between a pair of contact plates can be easily ascertained. The desired combinations of dimmer positions can then be reproduced in any desired order by operating the mechanism as described. Furthermore the overall intensity of any lighting combination can be varied without disturbing the relative strengths of the lighting circuits.

As an alternative to fitting new contact plates or strips etc., as shown in the previous paragraph, each pair of contact plates may be replaced by a series of adjustable members of the type shown in Figure 9, mounted in a row as shown in Figure 10. Each unit member (see Figure 9) according to this particular construction which is cited as an example, consists of two metal contact strips 54 and 53 mounted with a gap between them on an insulated base 55. These two contact strips are electrically insulated from each other, but make contact, one at either end with common conductors for the row, so that all the contact plates coming below the gap between plates are electrically connected to one common conductor 60 while all the contact plates coming above the gaps are electrically connected to another common conductor 59. These conductors cause a row of such members to correspond electrically to a pair of contact plates of the type described earlier in this description. It will be seen in Figure 10 that the circular units are so mounted in a common base that only a small part of the surface projects beyond the insulated sur-

face of the base 57, this projection being shown at 58*r*, 58*s*, 58*t*, 58*q*.

The contact brushes 26*a*, 26*b*, 26*c*, 26*d*, engage with the fore-mentioned surfaces 58*r*, 58*s*, 58*t*, 58*q*, and the slidable base 57 is mounted so that its stopping positions always bring the contact brushes against one circular contact member in each row.

Each circular contact member is mounted so that when the setscrew 58 is loosened the member may be rotated by hand until the position of the spiral gap between the two contact plates comes at the desired point in the path of travel of the contact brush associated with it. The setscrew is then tightened. In this manner the position of the gap between the electrically continuous contact plates can be varied as desired at each stopping place of the multiple assembly. With a construction of this nature it is desirable to provide easy access to the side of the mounting base from which the adjustments are made and some kind of a scale can be mounted on or adjacent to each adjustable member corresponding say to the scale adjacent to the hand operated dimmer handles 14*a*, 14*b*, 14*c*, 14*d* so that when the desired dimmer position is known the necessary adjustment to the contact plate circular member can be quickly carried out.

An alternative method of providing means of adjustment of the stopping positions of the dimmers, is to use the type of construction shown in Figure 8, but to provide means of easily adjusting the position of the member 51*a*. For example this can take the form of a stud fixed in a slot so that the position of the stud in this slot can be easily adjusted. In this form of construction the position of the member 51*a* corresponds in value to the position of the gap in the construction shown in Figure 5.

Figure 6 shows a perspective view of a complete apparatus constructed according to this invention, but the means of access to adjust the members just described is not shown. This access is quite easily provided however, and for example part of the front cover could be removable to provide this access. While four dimmers have been assumed in the descriptions above, the apparatus is not restricted to any number, and to illustrate this a further two dimmers have been indicated by the handles 45 and 46.

Summarising the operation of the equipment as shown in Figure 6 it may be said that:

(a) The handles 14*a*, 14*b*, 14*c*, 14*d*, 45, 46, enable the dimmer circuits to be individually operated by hand so that among other things the desired dimmer positions may be ascertained by experiment.

(b) By means of the handwheel 35 a desired preset combination of dimmer positions may be preselected, in conjunction with scale 37.

(c) The selection can be carried into effect by operation of the handwheel 43.

(d) The overall intensity of the lighting provided by all the dimmer lighting circuits can be reduced or increased before or after a selected combination of dimmer positions has been carried into effect, by operation of the handwheel 42.

(e) Adjustments of the dimmer positions can be preset by opening up one or more of the panels which enclose the apparatus, and either fitting new contact plates or strips, in the compound switch mechanism, or adjusting contact members provided for this purpose as shown for example in Figures 9 and 10.

The construction so far considered according to this invention concerns manually operated apparatus. If desired, however, any or all of the operations concerned in the working of the apparatus may be operated automatically by any desired means such as hydraulic or electric power.

Apparatus can be constructed according to this invention whereby a sequence of lighting changes can be automatically produced by the control apparatus in accordance with predetermined requirements. In one form of construction the movable base member of the compound switch mechanism is circular so that the contact plates or strips may be rotated continuously in one direction. The shaft 6 is continuously rotated by electrical or other means while the movable base member just described is inched round at intervals. These intervals can be of a certain duration regardless of the time required for any lighting change, or means may be provided to inch the member round to its next position as soon as a lighting change has been completed. One means of accomplishing the latter requirement is to cause a relay to operate as soon as there is no current flowing through the return conductor for all the electro-magnetic clutch coils, this relay causing a solenoid to inch the rotatable switch base member to the next position. It will be appreciated that while a lighting change is in course of action there will be current flowing through at least one magnet coil but as soon as all dimmers have come to rest then there will be no current flowing through the return feed.

It will be appreciated that contacts which cause lighting circuits to be just switched on or off, either directly or by

means of relays can be mounted, on the movable base member of the compound switch mechanism, either alone or in at the same time as contact plates or strips etc., for dimmer control. Thus in addition to a number of circuits provided with dimmers there may be other circuits which are either on or off without means of brightness variation. It is possible to mount a series of contacts on the insulated part of the movable base member for this purpose, or alternatively these contacts may be mounted on another mounting which moves in conjunction with the former. Thus a number of circuits can be directly switched on or off when the movable base member of the compound switch mechanism of the apparatus is moved to another position. It may be desirable however to provide some form of delayed action in some cases so that these switch contacts are not effective until the dimmer changes begin to take place, and this may be more easily achieved if the switch contacts in question are mounted on a separate base to the dimmer contact plates or strips etc., but arranged to come into operation as and when desired.

It will also be understood that various switches for the control of the different circuits controlled by the apparatus and for the supply of electricity to it, may be mounted upon the control apparatus but for the sake of simplicity these have not been shown on the drawings accompanying this description.

Dated this 28th day of May, 1947.
F. J. CLEVELAND & COMPANY,
Chartered Patent Agents,
29, Southampton Buildings,
Chancery Lane, London, W.C.2.

COMPLETE SPECIFICATION

Improvements in Electric Lighting Control Apparatus

I, ROLLO GILLESPIE WILLIAMS, a British Subject, of Apartment 1Z, 20, Clent Road, Great Neck, Long Island, New York, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to a control apparatus for electric lighting by which a predetermined cycle or pattern of variation, in the intensity of each of a plurality of light sources, may be effected. Particular instances of the possible uses of the apparatus are in stage lighting for theatres, and in shop window lighting for display.

A control apparatus of this kind has already been proposed comprising a dimmer for each light source, a separate reversible electrically-operated coupling means between each dimmer and a driving means, a variable time-influenced circuit breaker for each dimmer, driven by the same means as the dimmer, and said coupling means being adapted for pre-set coupling to the said driving means and for automatic selective uncoupling from such means under the control of the respective circuit breakers. The term "dimmer" in this specification is to be regarded as denoting any type of device for varying the intensity of the light from an electric lamp, including electronic devices, auto-transformers and wire wound dimmers, the most usual device for this purpose being a rheostat or variable resistance. The term "light source" must be regarded as denoting either a single lamp or a plurality of lamps, and giving either a white light or any kind of coloured light.

The present invention is concerned with apparatus having the above-stated characteristics and relates more particularly to the circuit breakers and the driving means therefor.

In a control apparatus according to the invention, each circuit breaker includes a pair of fixed contacts and a movable contact in the circuit of the reversible coupling means (the terms "fixed" and "movable" being interchangeable) the movable contact being connected for progressive movement with progressive movement of the movable element of the dimmer and passing through a neutral position when moving from one fixed contact (for a drive in one direction) to the other fixed contact (for a drive in the other direction). Conveniently the movable contact is an extensible oscillatory member and in such event the invention may be further characterised in that the fixed contacts are capable of advancement and retraction towards and away from the centre of oscillation so as to vary the extent of sliding contact for a given angular displacement. This allows of a lengthening or shortening of the total time period for the complete cycle of change without varying the relative time values for the individual changes.

The invention may be further character-

ised in that the pre-set coupling of the operating member to the drive to the movable contact (and the dimmer) is such as to allow a selective coupling being established at any point in the path of the moving contact, so as to vary the time period and extent of movement before the neutral position is reached.

In some forms of the invention the movement imparted to the movable contact by the drive to the dimmer causes such contact to slide over one or other of the fixed contacts until it arrives at the neutral point. In some other forms of the invention, the drive to the dimmer imparts movement to the fixed and moving contacts as a whole, and cam means is employed to cause the fixed and moving contacts to separate when the neutral position is reached and to re-engage when the neutral position is left.

Apparatus made according to the present invention, may be used to control the lighting intensity of a plurality of light sources of the same colour, or light sources emitting, say, white light, blue light and red light respectively. By varying the relative intensity of the component light sources, any desired results may be produced and if the light sources are different in colour any desired colours may be produced.

The invention provides a device of the kind set forth in which the overall intensity of a composite light effect may be varied without a change in character, by simultaneously and proportionally varying the intensity of the various constituent light sources, in which the change from one resultant light effect, such as colour, to the next selected one will take place gradually and in any desired order, and in which the lighting requirements may be set up in advance in such a manner that a number of desired pre-set combinations of dimmers and lighting circuits may be reproduced at any time, irrespective of the order of the changes. The changes from one pre-set combination to another may take place at any desired speed and the dimmers or brightness regulators (when dimmer changes are involved) will always move directly to the required positions. The apparatus may be constructed for the pre-setting of a large number of lighting combinations.

For the achievement of this last-named end, the several fixed contacts may be displaceable laterally, i.e. at an angle to the direction of movement of the moving contacts over them, and thereby be presented to the moving contacts (or some of them) in new relationships so as to reach the neutral points in shorter or longer times. This may be effected, for example in cases where the moving contact slides over the fixed contacts, by having the fixed contacts in various widths at different points in their length so as to vary the position of the neutral point; or, in cases where the said cam means is employed, by varying the shape of the cam. This last arrangement may be and preferably will be, modified in that the cams will be displaced laterally in relation to the fixed and moving contacts.

Some or all of the lighting controlled may be of a single circuit equipment type, giving only one colour of light, in other words the combination of the lighting circuits is not dependent on the need for colour blending, although in practice it may be that some or all of the lighting circuits may be selected with this end in view. For example, a number of the circuits may have single lampbulb spotlights connected thereto and arranged to give white light, while other circuits may control multi-circuit (i.e. multi-colour) equipment in which the circuits correspond with lighting of different colours and are blended to give desired colour lighting effects. In such a case the lighting requirements from time to time in the lighting plot might require variations in the strength of the spotlighting as well as variations in the number of spotlights in use, while at the same time the number and strength of the circuits in the multi-colour lighting equipment would vary according to the need for changes in the colour of the lighting provided thereby.

There may be a single control apparatus, for any desired number of lighting circuits, and, if desired, the whole of the circuits, say for a complete stage installation, can be determined from a single pre-set indicator with its associated operating mechanism according to this invention. Alternatively, it may be preferred to have a number of unit control mechanisms each governing a desired number of the lighting circuits. In the latter case means of collective operation of the various operating mechanisms may be provided.

This invention also makes it possible, as will be clear from a consideration of the following examples, for overall lighting intensity of all the circuits in use to be varied so that a change in overall intensity is proportional (or very nearly proportional) to their original and relative strengths in each case. Thus, if an arrangement of dimmers first included dimmer A at 100%, dimmer B at 80%, dimmer C at 60% of full light and dimmer D at zero per cent., then a reduction of intensity to one half would result in dimmer A at 50%, dimmer B at 40%, dimmer C at 30% of full light while

dimmer D remains at zero per cent., instead of dimmer A at 50%, dimmer B at 30% and dimmer C at 10% of full light, as would be the case if all four dimmers were to each move an equal amount. Among other things this enables a lighting arrangement to be varied in overall intensity without the various circuits losing their light relationship to each other. Means for experimentation with the lighting controls and dimmers can be provided and they can be operated independently of the present effects, or the preset effects can be modified and/or changed as required.

The invention, in its preferred forms, is characterised by a plurality of shaped contact plates, arranged in pairs in generally-parallel disposition, the shaped edges mating with each other but at a little distance apart, contact with one plate driving the dimmer in one direction and contact with the other plate driving the dimmer in the other direction. A corresponding plurality of contacts movable over the said plates and across the space between them, and means for moving the plates in the direction of their parallel disposition to present varying parts of the shapes to the moving contacts. Such plates may be mounted on a common carrier slidable in guides, and where the moving contacts are radially disposed, as above outlined, such guides may themselves be movable (with the said carrier) towards and away from the centres about which the radial members oscillate.

In alternative forms, there are a plurality of shaped cams, in generally-parallel disposition, a corresponding plurality of cam followers movable across the cams, the cams being displaceable together in the direction of their parallel disposition to present varying parts of the shapes to the followers, and a set of fixed and movable contacts (as above set forth) in association with each follower for operation by the cam.

In order that the invention may be more clearly understood, a number of illustrative constructions will now be described with reference to the accompanying drawings, and the drawings accompanying the provisional specification, in which:—

Fig. 1 is a plan view of one form of control apparatus, the casing being shown in section.

Fig. 2 is a sectional elevation of the control taken on the line 2—2 of Fig. 1.

Fig. 3 is a cross-section (to a larger scale) taken on the line 3—3 of Fig. 2.

Fig. 4 is a cross-section taken on the line 4—4 of Fig. 2.

Fig. 5 is a partial section (to a larger scale) of certain parts shown in elevation in Fig. 2.

Fig. 6 is a perspective view of the complete control apparatus.

Fig. 7 is a schematic circuit diagram of the various parts of the control.

Fig. 8 shows a modified form of the movable circuit controlling means.

Fig. 9 and Fig. 10 show still further modified forms of the movable circuit controlling surface.

Figs. 11, 12, 13 and 14 show various modified forms of the circuit controlling switch means.

Fig. 15 shows a plan view of the interior of a modified form of control apparatus.

Fig. 16 shows a partial sectional elevation of the apparatus taken on the line 16—16 of Fig. 15.

Fig. 17 shows an elevation of the apparatus of Fig. 15 showing the movable surface and follow up means taken on the line 17—17 of Fig. 15.

Fig. 18 shows a form of indicator for use with the apparatus of Fig. 15, together with an improved pre-set step-by-step control arrangement.

Fig. 19 shows a schematic circuit diagram indicating the working of the pre-set step-by-step control means, and

Fig. 20 shows a modified form of movable surface for use in the apparatus according to Fig. 15.

The illustrative apparatus of the form shown in Figs. 1 to 10 inc., consists of a framework 44 in which are mounted by way of example four rotary stud type totally enclosed dimmers 1A, 1B, 1C, 1D. Rotary motion is imparted to these dimmers by some convenient means, in this case a rack and pinion for each dimmer (2*a*—3*a*, 2*b*—3*b*, 2*c*—3*c*, 2*d*—3*d*) connected by link rods 4*a*, 4*b*, 4*c*, 4*d* respectively, to hand-operated levers 5*a*, 5*b*, 5*c*, 5*d*, respectively, mounted on the shaft 6. Individual hand operation of the dimmers can be obtained by manipulation of the handles 14*a*, 14*b*, 14*c*, 14*d*, fixed at the ends of the levers 5*a*, 5*b*, 5*c*, 5*d*, respectively.

The levers 5*a*, 5*b*, 5*c*, 5*d* are loosely mounted on the shaft 6, and each lever carries two electromagnets (12*a* and 13*a*, 12*b* and 13*b*, 12*c* and 13*c*, 12*d* and 13*d*) with the projecting part of the iron cores facing in opposite directions, so that electromagnet 12*a*, for example, will attach itself to the iron plate fastened to the inside face of the bevel wheel 7*a*, when energized; while magnet 13*a* will attach itself to the iron plate inside bevel wheel 6*a*, when energized. While there is a slight gap between the magnet cores and the iron plates when both coils are de-energized, by providing a small amount of play between the levers 5*a*, 5*b*, 5*c*, 5*d* and the shaft 6,

either magnet can pull its mounting lever over slightly when energized so as to attach itself to the iron plate adjacent to it.

The levers and magnet coils just described are mounted so that each lever comes between a pair of bevel wheels 6*a* and 7*a*, 6*b* and 7*b*, 6*c* and 7*c*, 6*d* and 7*d*. One wheel of each pair, in this case 6*a*, 6*b*, 6*c*, 6*d* is fastened to the shaft 6 by means of screws 9*a*, 9*b*, 9*c*, 9*d*, while the other wheel of each pair is loosely mounted on this shaft but is prevented from moving sideways by pins 10*a*, 10*b*, 10*c*, 10*d*, which locate in corresponding grooves in the shaft 6. Each pair of bevel wheels, however, are linked by a third bevel wheel 8*a*, 8*b*, 8*c*, 8*d* respectively, so that motion can be imparted to the loosely mounted wheels 7*a*, 7*b*, 7*c*, 7*d*, if the shaft 6 to which are fastened the bevel wheels 6*a*, 6*b*, 6*c*, 6*d*, is rotated. The loosely mounted bevel wheels 7*a*, 7*b*, 7*c*, 7*d*, however, will rotate in the opposite direction to that of the shaft 6 and the wheels 6*a*, 6*b*, 6*c*, 6*d*.

If the shaft 6 is rotated, the levers 5*a*, 5*b*, 5*c*, 5*d*, will move in the same direction as the shaft if and while the magnet coils 13*a*, 13*b*, 13*c*, 13*d* are energized but will move in the opposite direction if and while the magnets 12*a* 12*b*, 12*c*, 12*d* are energized.

It will be seen from Fig. 7 that each pair of electromagnets are electrically connected to a pair of contact plates. Thus, magnet 12*a* is connected to contact plate 16*a* and magnet 13*a* is connected to contact plate 15*a*; magnet 12*b* to plate 16*b* and magnet 13*b* to plate 15*b*, etc. The four pairs of contact plates 15*a*—16*a*, 15*b*—16*b*, 15*c*—16*c*, 15*d*—16*d* are shown in Figs. 2 and 4 mounted upon a common base 18. It will be seen from Fig. 4 that there is a gap between each pair of contact plates, the four gaps being shown at 17*a*, 17*b*, 17*c*, 17*d*. While these gaps (or neutral paths) are shown in Fig. 4 as made up of a number of straight portions, it is to be understood that they may be formed as curvilinear paths, somewhat as shown in Fig. 17, in which event the slightest transverse movement of the contact plates may result in a change of position thereof in a vertical direction. The shape of the neutral paths of Fig. 4 (or Fig. 17) is always so designed as to give the desired light intensity at any given point along the length of each circuit controlling plate in relation to the intensity of the light controlled by the other plates. These circuit controlling plates constitute a pattern in the form of a neutral path which serves to control the circuits to give the light intensity predetermined by said pattern. The base 18 upon which the four pairs of contact plates are mounted is made of insulating material, or alternatively other means are taken to insulate the various contact plates from each other.

Electricity is directed at times to one or the other contact plate of each pair, by means of a contact brush. Fig. 5 shows a contact brush assembly in which a contact brush 26*a* is held in a holder 23*a* and pressed against the contact plate assembly by means of a spring 27*a*. Since there are four pairs of contact plates, there are four contact arm assemblies and these are shown in Fig. 2 at 23*a*, 23*b*, 23*c* and 23*d*. It will be seen that these brush-holders are pivoted at 22*a*, 22*b*, 22*c*, 22*d* between the upright supports 24*a* and 24*b*. These brush-holders have lever arms 21*a*, 21*b*, 21*c*, 21*d* attached to them so that movement of these levers will cause a corresponding movement of the brush-holders and the contact brushes 26*a*, 26*b*, 26*c*, 26*d*, and the latter will be able to move over the surface of the contact plates adjacent to them.

The lever arms 21*a*, 21*b*, 21*c*, 21*d* are shaped to terminate at different positions on plan as will be seen from Fig. 4 and the opposite ends to the brush-holder end of these levers are spaced out at approximately the same distance apart as the distances between the four dimmers 1A, 1B, 1C, 1D, so that they can be linked by connecting rods to the link assemblies which in turn connect the dimmers to the levers 5*a*, 5*b*, 5*c*, 5*d*.

Thus, the rack 3*a* which operates the pinion 2*a* on the dimmer 1*a* is connected from a pivot at 20*a* by means of connecting rod 19*a* to the lever 21*a* which is associated with the brush-holder 23*a*. Similarly, rack 3*b* is connected by rod 19*b* to the lever arm 21*b*, which operates brush-holder 23*b*; rack 3*c* by means of rod 19*c* to lever arm 21*c* and brush-holder 23*c*; and rack 3*d* by means of rod 19*d* to lever arm 21*d* and brush-holder 23*d*. Thus, movement of the dimmer 1A will cause the contact brush 26*a* in the brush holder 23*a* to move in accord with the dimmer. Similarly, the dimmer 1B will cause a corresponding movement of contact brush 26*b*; dimmer 1C a movement of contact brush 26*c*; and dimmer 1D a corresponding movement of contact brush 26*d*.

If no electricity is flowing from the contact brushes to the electromagnets 12*a*, 12*b*, 12*c*, 12*d* and 13*a*, 13*b*, 13*c*, 13*d*, then the dimmers can be moved freely by hand by means of the handles 14*a*, 14*b*, 14*c*, 14*d*, and the contact brushes 26*a*, 26*b*, 26*c*, 26*d* will move over their correspond-

ing pairs of contact plates 15*a*—16*a*, 15*b*—16*b*, 15*c*—16*c*, 15*d*—16*d*, without anything happening as the result of these contacts. To permit this free movement when the apparatus is in normal use, the supply of electricity is broken by some convenient switch or switches, in the example under consideration, there being a switch of the press-button type at the end of each dimmer operating handle as shown at 47*a*, 47*b*, 47*c*, 47*d*. Thus, pressure of the button 47*a* by the thumb will break the supply of electricity to the electromagnets associated with the handle 14*a* and allow the dimmer 1A to be freely adjusted by hand. This is further shown in Fig. 7 where the switches are shown as part of the return feed from the electromagnet coils.

When current is flowing through the contact plate circuits, however, the effect will be to energize one of the two electromagnet coils in each set, unless the contact brush happens to rest in the gap between a pair of contact plates, in which case that particular circuit will, of course, be broken. The said "gap" between the contact plates constitutes a neutral path which, when reached by the associated contact brush, will cause the electric circuit to the associated magnet to be broken and the movement of the associated dimmer to be stopped at the position determined by the part of the gap or neutral path then in line with said contact brush. The neutral path may take other forms, such as shown in Figs. 14, 16 and 17, where the neutral path is formed as an inclined edge on a pattern plate serving to control a single-pole, double-throw switch. Where the expression "gap" is used, it is, of course, to be understood as including any equivalent structure involving a pattern providing a neutral path.

Energization of one of the magnet coils will not of itself cause any change in the position of its associated dimmer but should the shaft 6 now be rotated by means of the handwheel 43, then the dimmer in question will now move either up or down, according to which of the side iron plates of each set of bevel wheels is gripped by an electromagnet.

The shaft 6 is arranged for rotation in one direction only, and the arrangement is such that whether the dimmer is going up or down, the contact brush assembly which moves in accord with it always moves toward the gap between the two contact plates. As soon as the brush reaches this gap, the supply of electricity to the magnet coils associated with these contact plates is broken and the dimmer ceases to move in conjunction with the shaft 6.

Thus, in Fig. 5 the contact brush 26*a* is shown in contact with the lower plate 16*a* and the effect of this will be to energize the coil 12*a* which will cause the dimmer to increase in brightness when the shaft 6 is rotated and at the same time cause the contact brush 26*a* to also move in an upward direction towards the gap 17*a*. As soon as the brush reaches this gap it will break the supply of electricity to either contact plate 15*a* or 16*a* and the dimmer will remain stationary and cease to move in accord with the rotation of shaft 6. Alternatively, had the contact brush 26*a* been touching contact plate 15*a*, then the other magnet coil in the set, i.e. 13*a*, would have been energized with the result that the dimmer would have moved in the opposite direction and the contact brush 26*a* would have moved downwards towards the gap 17*a*.

The position of the gap between the two contact plates of each set therefore determines the stopping position of each dimmer. It will be seen from Fig. 4 that the position of the gap between each pair of contact plates varies along the length of the plates. Furthermore, that the position of the gap between any one pair of contact plate varies at any given point along the length of the plates relative to one or more of the other sets of plates. Thus, in Fig. 4 the four contact brushes 26*a*, 26*b*, 26*c*, 26*d* are shown at a position in the middle of the length of the four pairs of contact plates, and in each case the brush is in contact with the lower plate of each pair, thus energizing magnets 12*a*, 12*b*, 12*c* and 12*d*, and causing all four dimmers to increase in brightness when the shaft 6 is rotated. The four contact brushes will at the same time move in an upward direction until each brush reaches the gap between the contact plates and both dimmers and brushes will remain stationary.

The base 18 upon which the four pairs of contact plates are mounted, is, however, slidably mounted in a frame 29 and can be moved in either direction at right-angles to the arc of travel of the contact brushes. Thus, in Fig. 4 it will be seen that the base 18 can move either to the left or the right of the position shown. This movement is achieved by means of a rack and pinion 33 and 32 in the construction under consideration but any suitable means can be employed. For example, in some constructions it might be desirable to cause the desired movement of the base 18 to take place as the result of turning a wheel or knob or by moving a lever located further away from or even at a distance from the base 18 in question.

Movement of the base 18 to a new position relative to the contact brushes 26*a*, 26*b*, 26*c*, 26*d*, will enable the gap between any pair of contact plates to be located in a new position relative to the path of travel of the associated contact brush, and the dimmer concerned will be given a new stopping position in accord with the position of the gap.

It will be seen that since all four sets of contact plates are mounted on the same base, they are moved as one unit when the base in question is moved, and the whole assembly becomes one compound contact-plate movable member. Together with the four movable brush-holders and brushes it forms one compound switch mechanism in which the base is moved as a single member to vary the location of the breaking points of the switch ways. During normal operation of this compound switch mechanism the supply of electricity to it is constant and displacement of part of the switch relative to the other part or parts determines the breaking point of any of the switch circuits. That is to say, this switch mechanism does not depend upon any external or additional apparatus or means to energize or determine the energization of the switch brushes or to determine the stopping points of these switch brushes.

It will be seen that movement of the movable base member of the compound switch mechanism simultaneously affects all the sets of contact plates and each of the dimmers can if desired be given a new stopping position. Thus, if the gaps between the contact plates are located beforehand to correspond with the desired position of the dimmers, movement of the movable contact plate member to a certain position will enable all the dimmers to be simultaneously moved to the predetermined positions as and when the shaft 6 is rotated. The dimmers will then directly move to the predetermined positions at a speed corresponding to the speed of rotation of the shaft 6.

In the construction shown in the accompanying drawings the shaft 6 is rotated by means of the handwheel 43 but any convenient means for turning this shaft may be employed such as an electric motor. When a number of separate sets of control apparatus according to this invention are grouped together, means may be provided to allow some or all of these shafts to be simultaneously rotated or rotated at different speeds.

While the pairs of contact plates have been so far shown as mounted on a common base 18 so that the relationship of the contact plates to the contact brushes may be simultaneously affected if desired the contact plates may be mounted on a separate base for each pair provided that they move together or can be made to move together as one unit. Means may, however, be provided to adjust the relationship of any pair of contact plates relative to the other pairs of contact plates.

The contact plates have been shown as mounted on an oblong base which is slidably mounted, but if desired the contact plates may be mounted on the face or periphery of a wheel or drum arranged to rotate or may be mounted in any other convenient manner.

It has been shown that movement of the movable base member of the compound switch mechanism will enable predetermined combinations of dimmer positions to be reproduced. In Figs. 1, 2 and 6 a pointer 36 is shown moving over a scale or name plate so that by turning the knob 35 an operator will be able to move the movable base member to the desired position. Any desired number of stopping positions for pre-set dimmer arrangements may be embodied in the apparatus described above.

The movable base member of the compound switch mechanism can also be arranged to be moved in another sense so that in addition to change of position as already described, it can also be moved nearer to the pivoting points 22*a*, 22*b*, 22*c*, 22*d* of the brush-holders 23*a*, 23*b*, 23*c*, 23*d*. In Fig. 4 it will be seen that the frame 29 which carries the slidable contact base 18 is in itself slidably mounted in another frame 38, and can be moved at right-angles to the sliding movement of base 18 by means of a rack 41 (see also Fig. 2) and pinion 39 which is mounted on a shaft 40 and turned by handwheel 42. Thus, this whole switch base assembly can be varied in its distance from the pivoting points described above. This does not affect the movement of the slidable base as the pinion 33 (see Figs. 1 and 2) is wide enough to remain in engagement with the rack 32 at all positions of the frame 29.

One means for automatically proportioning the light intensity of the several light sources will now be described. It will be seen from Fig. 5 that when the contact plates 15*a* and 16*a* are moved from position AA to another position BB which is nearer to the pivoting point of the brush-holder 23*a*, the contact brush 26*a* is pressed into the brush-holder and it will have to move through a greater angle to reach the gap 17*a* unless this gap is located in direct line through the brush and brush-holder. Thus, in Fig. 5 the arc of travel of the contact brush will be

increased from CC to C^1C^1 when the contact plates are moved from AA to BB in order to reach the gap or neutral path 17*a*. Inasmuch as the movement of the brush is related to the movement of the dimmer associated with it, the dimmer will travel further when the contact brush moves from the horizontal position shown in Fig. 5 to the gap 17*a* when this is located on the line BB.

When calculating the positions of the gaps between the contact plates, it is arranged that the lowest position of a dimmer shall be reached when the gap is directly in line through the contact brush and holder. To get full light from a dimmer, the gap is situated so that the contact brush and arm have to travel through the maximum arc of travel. The maximum arc of travel is only reached when the contact plates are at the shortest distance from the pivoting points of the brush-holders, i.e. in Fig. 5 at BB. To get full light from any of the dimmer circuits, it is necessary for the movable base member 18 to be at its nearest position to the pivoting points of the brush-holders, i.e. at position BB in Fig. 5. The dimmers will then take up their relative position as determined by the position of the gaps between the contact plates and the maximum overall lighting intensity will be obtained from the lighting apparatus controlled by the dimmers.

When by movement of the wheel 42 the movable base member 18 is taken further away from the pivoting points of the brush-holders then on the line BB then the dimmers will take up the same relative position to each other, but since the contact brushes 26*a*, 26*b*, 26*c*, 26*d* will now move through a smaller arc of travel in order to reach the gaps between the contact plates, the dimmers will stop further away from the "full light" positions thus giving a lower overall lighting intensity.

While no difficulties are experienced in causing the dimmer arms in the dimmers to stop short of their extreme "full light" position, it is important that at the opposite end of their travel these dimmer arms are not required to go beyond the "full out" position as with most designs of dimmer the arms cannot travel beyond this point. Thus, while all the dimmers in a combination can be made to stop further away from the "full light" positions as explained in previous paragraphs, movement of the dimmer arms must always stop when they reach their "full out" positions. This is ensured by arranging that the gap between each pair of contact plates corresponds to the "full out" position of a dimmer when this gap is directly in line with the brush-holder when this is at right-angles to the thrust of the contact plate assembly. At this position variation of the distance between the contact plates and the pivoting point of the brush-holder makes no difference to the relative position of the gap and contact brush. It is only when the contact brush is not at right-angles that there is a variation in its arc of travel in order to reach a given position of the gap between a pair of contact plates.

In the operation of the apparatus, the dimmers will always stop at the "full out" positions together regardless of their different starting points, assuming that this effect as required. From the foregoing, it will be seen also that variation of the distance between the contact plates and the pivoting points of the brush-holders will affect all the dimmers in proportion to their relative positions. Thus, if the arc of travel is reduced, say, by 25% for a dimmer at "full light" position, the arc of travel of other dimmers giving various strengths of light will also be reduced by approximately the same amount, so that another dimmer, say at one half of full light, will have its travel reduced by 25% of one half. Thus, the overall intensity of light provided by dimmer circuits at various strengths can be varied without upsetting the proportion of light provided by the different dimmer circuits. If desired, the apparatus can be constructed so that dimmers can be caused to move from "full light" to "loss of light" simply as the result of moving the base 18 far enough away from the pivoting points of the brush-holders and then operating the shaft 6.

From the foregoing description of the control apparatus, it will be seen that lighting effects can be tried out experimentally by means of the individual dimmer operating handles 14*a*, 14*b*, 14*c*, 14*d*, and when the desired effects are known, contact plates are cut and fitted in the compound switch mechanism. By fitting scales at the side of the dimmer operating handles the corresponding position of the gap between a pair of contact plates can be easily ascertained. The desired combinations of dimmer positions can then be reproduced in any desired order by operating the mechanism as described. Furthermore, the overall intensity of any lighting combination can be varied without disturbing the relative strengths of the lighting circuits.

As an alternative to fitting new contact plates or strips, etc., as shown in the previous paragraph, each pair of

contact plates may be replaced by a series of adjustable members of the type shown in Fig. 9, mounted in a row as shown in Fig. 10. Each unit member (see Fig. 9) according to this particular construction which is cited as an example, consists of two metal contact strips 54 and 53 mounted with a gap between them on an insulated base 55. These two contact strips are electrically insulated from each other, but make contact one at either end with common conductors for the row, so that all the contact plates coming below the gap between plates are electrically connected to one common conductor 60, while all the contact plates coming above the gaps are electrically connected to another common conductor 59. These conductors cause a row of such members to correspond electrically to a pair of contact plates of the type described earlier in this description. It will be seen in Fig. 10 that the circular units are so mounted in a common base that only a small part of the surface projects beyond the insulated surface of the base 57, this projection being shown at 58*r*, 58*s*, 58*t*, 58*q*.

The contact brushes 26*a*, 26*b*, 26*c*, 26*d*, engage with the fore-mentioned surfaces 58*r*, 58*s*, 58*t*, 58*q*, and the slidable base 57 is mounted so that its stopping positions always bring the contact brushes against one circular contact member in each row.

Each circular contact member is mounted so that when the setscrew 58 is loosened the member may be rotated by hand until the position of the spiral gap between the two contact plates comes at the desired point in the path of travel of the contact brush associated with it. The setscrew is then tightened. In this manner the position of the gap between the electrically continuous contact plates can be varied as desired at each stopping place of the multiple assembly. With a construction of this nature it is desirable to provide easy access to the side of the mounting base from which the adjustments are made and some kind of a scale can be mounted on or adjacent to each adjustable member corresponding, say, to the scale adjacent to the hand-operated dimmer handles 14*a*, 14*b*, 14*c*, 14*d*, so that when the desired dimmer position is known, the necessary adjustment to the contact plate circular member can be quickly carried out.

An alternative method of providing means of adjustment of the stopping positions of the dimmers, is to use the type of construction shown in Fig. 8, but to provide means for easily adjusting the position of the member 51*a*. For example, this can take the form of a stud fixed in a slot so that the position of the stud in this slot can be easily adjusted. In this form of construction the position of the member 51*a* corresponds in value to the position of the gap in the construction shown in Figure 5. 48*a* and 49*a* represent the contact plates and 50*a* the neutral point between them.

In effect, and with the operating member rotating at a constant speed, the moving and fixed contact constitute a time switch controlling the duration of the operation of the respective dimmers. From this point of view therefore, the invention may be defined as comprising a dimmer for each light source, a time switch for each dimmer for progressively bringing the respective dimmers to the "full-out" or to a "full-on" position, separate reversible electric coupling means between each dimmer (with its associated time switch) and a single constant speed operating member, and means for engaging the respective couplings at any selected time period prior to the arrival at said "full-out" or "full-on" positions each such time switch including two fixed and one moving contacts, the latter receiving movement from the drive to the dimmer, and passing through a neutral point when moving from one fixed contact to the other, at which neutral point it interrupts the driving means.

Fig. 6 shows a perspective view of a complete apparatus constructed according to this invention, but the means of access to adjust the members just described is not shown. This access is quite easily provided, however, and, for example, part of the front cover could be removable to provide this access. While four dimmers have been assumed in the descriptions above, the apparatus is not restricted to any number, and to illustrate this a further two dimmers have been indicated by the handles 45 and 46.

Summarizing the operating of the equipment as shown in Fig. 6, it may be said that:

(a) The handles 14*a*, 14*b*, 14*c*, 14*d*, 45, 46, enable the dimmer circuits to be individually operated by hand so that among other things the desired dimmer positions may be ascertained by experiment.

(b) By means of the handwheel 35 a desired preset combination of dimmer positions may be preselected, in conjunction with scale 37.

(c) The selection can be carried into effect by operation of the handwheel 43.

(d) The overall intensity of the lighting provided by all the dimmer lighting

circuits can be selected for reduction or increase before or after a selected combination of dimmer positions has been carried into effect, by operation of the handwheel 42.

(e) Adjustments of the dimmer positions can be pre-set by opening up one or more of the panels which enclose the apparatus, and either fitting new contact plates or strips in the compound switch mechanism, or adjusting contact members provided for this purpose as shown, for example, in Figs. 9 and 10.

The construction so far considered according to this invention concerns manually operated apparatus. If desired, however, any or all of the operations concerned in the working of the apparatus may be operated automatically by any desired means such as hydraulic or electric power.

Apparatus can be constructed according to this invention whereby a sequence of lighting changes can be automatically produced by the control apparatus in accordance with predetermined requirements. In one form of construction the movable base member of the compound switch mechanism is circular so that the contact plates or strips may be rotated continuously in one direction. The shaft 6 is continuously rotated by electrical or other means while the movable base member just described is inched round at intervals. These intervals can be of a certain duration regardless of the time required for any lighting change, or means may be provided to inch the member round to its next position as soon as a lighting change has been completed. One means of accomplishing the latter requirement is to cause a relay to operate as soon as there is no current flowing through the return conductor for all the electromagnetic clutch coils, this relay causing a solenoid to inch the rotatable switch base member to the next position. It will be appreciated that while a lighting change is in course of action there will be current flowing through at least one magnet coil, but as soon as all dimmers have come to rest, then there will be no current flowing through the return feed.

Referring again to Fig. 5, it will be seen that the contact brush 26*a* and arm 23*a* are at right-angles to the contact plates 15*a* and 16*a* when the brightness control is at the lowest or "dim out" position. The brightness control or dimmer is at its "full on" position when contact brush 26*a* is in contact with a certain position of the upper contact plate 15*a*. Between these extreme positions the contact point at the end of 26*a* moves in a straight line parallel with contact plates 15*a* and 16*a*. This path of travel is at right-angles to the position of the arm in the "dim out" position.

The constructions shown in Figs. 11 to 14 represent improved working arrangements for the contact brushes. In the construction shown in Fig. 11, better contact between the contact brush 26*a* and the contact plates 15*a* and 16*a* is achieved. Here the extending arm 66*a* does not make any electrical contact but operates with a roller 67*a* at one end to reduce friction and moves the contact brush 69*a* by means of a linking lever 68*a*. The contact brush 69*a* moves in exactly the same direction as the contact point at the end of contact brush 26*a* in Fig. 5, but the pressure of the brush against the two contact plates 15*a* and 16*a* remains constant. Also the distance between the pivoting point of arm 66*a* and a line parallel with the contact plates is capable of variation in exactly the same manner as the construction of Fig. 5.

Fig. 12 shows a further method of achieving similar results. The fork 70 will determine the line of movement of connecting pin 71 and will thus fix its distance from the fulcrum point 79 of the lever arm 72, the pin 71 being movable in slot 78 with respect to arm 72. The linking arm 73 will cause sliding bar 74 carrying contact brush 75 to move across the surface of the contact plates 76 and 77. It will be observed that movement of the fork 70 in the direction of the arrows will enable the effective length of the arm 72 to be varied and thus enable the effective strength of a particular lighting combination to be varied without alteration of the combination. A development of this construction is shown in Fig. 13 in which the fork 80 guides a roller 81 on top of the curved edge of lever 82 with a fulcrum point at 83. The roller 81 is pressed against the top of lever 82 by means of the spring 84. It will be seen that the construction of Fig. 13 is the geometrical equivalent of Fig. 5 and operates in substantially the same manner and forms the basis of the control apparatus to be described with reference to Fig. 15 *et seq*. The switch construction shown in Fig. 14 is designed to avoid having live contact plates and comprises a stylus pin 90 connected to but insulated from a spring arm 91, the latter carrying electrical contact points 92 and 93. The spring arm 91 is continually energized, and when in the middle position as shown in Fig. 14, the contacts 92 and 93 make no contact with contacts 94 or 95. To be in this middle or neutral position, the stylus 90 is located approximately in the center of an incline 96 which connects two

levels 97 and 98 of the movable surface. When stylus 90 is moved so as to come on the lower level 97, spring arm 91 moves over by its own springiness so that the contact 92 touches contact 94 and energizes power-operated means to return the operating linkage so that the stylus will break this contact. Similarly, when stylus 90 is on the higher level 98, contact 93 touches contact 95 and energizes the same power-operated means to return the stylus to the incline. By this arrangement it will be seen that the stylus will follow the movement of this incline or neutral path over the movable surface. In fact this incline constitutes a neutral path.

In the construction shown in Figs. 15, 16 and 17, a handwheel 100 is mounted on a shaft 101 and by means of bevel gears 102 and 103 causes shaft 104 to be rotated. Shaft 104 is only intended to rotate in one direction, that is clockwise as seen in Fig. 16, and if handle 100 is turned in an anti-clockwise direction, a one way drive device 118 will cause the handle to rotate freely on shaft 101. A single complete magnetic clutch is shown in section in Fig. 17, and it will be seen that shaft 104 has fixed thereto a circular iron contact plate 105. Loosely mounted on shaft 104 but not secured to it are two circular plates 106 and 107, preferably made of aluminum or other non-magnetic material. Plate 106 carries two electromagnets 108 and 109 and plate 107 carries two similar electromagnets 110 and 111. When neither of the pairs of electromagnets are energized, the center iron plate 105 may rotate with shaft 104 without moving either of the aluminium plates 106 and 107. If the electromagnets on plate 106 are energized, they become magnetically attached to the iron plate 105, and the aluminium plate 106 will turn with iron plate 105. Similarly, when the electromagnets on aluminium plate 107 are energized, they will become attached to iron plate 105 and thus aluminium plate 107 will turn with the iron plate 105. The aluminium plates 106 and 107 are grooved on their peripheries and a wire cable drive 119 is taken from each of pulleys 112 and 113, both of which are fastened to the operating shaft 114 of dimmer 120. The single wire cable is arranged so that it passes from the top edge of plate 106 to the top edge of pulley 112, thence to the underneath of pulley 112 to the top of plate 107, thence to the underneath of plate 107 to the top of pulley 113, and from the underneath of pulley 113 to the underneath of plate 106. This arrangement which is clearly illustrated in Fig. 16, causes aluminium plate 106 to rotate in the opposite direction to the aluminium plate 107. When the electromagnets on plate 106 are energized, then the latter will turn in the same direction as the dimmer shaft 104 and aluminum plate 107 idles in the opposite direction. If, however, the electromagnets on plate 107 are energized, then the dimmer will rotate in the opposite direction as a result of the cross-over cable drive operating on the dimmer pulley 113. An advantage of this construction is that it keeps the two aluminium plates in the closest possible proximity with the iron plate.

Dimmer 120 carries on its shaft 114 a cam 121 (see also Fig. 16) rotating with pulleys 112 and 113. The outer edge of cam 121 presses against roller 122 at the end of arm 123^a mounted on one end of shaft 124*a*. The other end of shaft 124*a* is fixed to an arm 125^a. The linkage shown in these Figures for operation of the follow up devices corresponds in principle to that shown in Fig. 13 and includes roller 126 which rides on top of arm 125^a and is located in position by movable fork 127, the latter being movable by means of rack and pinion 129 and 130 which move the base 128 carrying the fork backwards or forwards along the length of the arm 125^a. Roller 126 is carried by a linking lever 131 which is pivoted at 132 to bar 133 which slides vertically in guides and carries the switch arrangement as shown and described with reference to Fig. 14 (this switch is not shown in detail in Figs. 15 to 17). In this form of apparatus four such assemblies are provided and are referred to by the same reference numbers but with suffixes *a*, *b*, *c* or *d*. While the magnetic clutches and dimmers can be spaced apart, it is preferable that the stylus pins of the switch assemblies should be located one above the other in a line perpendicular to the direction of movement of the movable surface. For this purpose it will be noted particularly in Fig. 15 that shafts 124*b*, and 124*c*, take in practice the form of a sleeve through the center of which the shafts 124*a* and 124*d* pass to enable the arms 125 to be located as closely together as possible. It will be seen from Figs. 15 and 17 that the forks 127 are located together on the same base 128 so that all the forks move together as one unit. Movement is imparted to the movable base carrying these forks by means of rack and pinion 129 and 130. Pinion 130 is mounted on a short shaft carrying bevel wheel 135 which is driven by bevel gear 136 (see Fig. 15) mounted on a further short shaft, which latter carries at its other end a chain sprocket wheel 137.

Chain 138 links sprocket wheels 137 and 139, the latter being mounted on shaft 116 which carries the control knob 117 which is mounted on the outside of the front panel of the machine. Thus, it will be seen that movement of control knob 117 causes the four forks 127 to adjust the distance of the four rollers 126, from the center of the four shafts 124.

When any dimmer is in its full " dim out " position, which means that arm 125 is horizontal, movement of fork 127 will change the position of roller 126 without in any way moving bar 133 which carries the switch assembly. Should the dimmer be " full on " or partly on, then movement of the fork will cause a change in the position of the switch assembly 134, and on movement of handwheel 100 will simultaneously give a proportional reduction of the position of all the dimmers, and consequently a proportional reduction of all the lights but, however, maintaining the same color combination. It will be appreciated that movement of the position of the switch assembly 134 does not in itself cause any movement of the dimmer control but simply determines the final position of the dimmer when the stylus pin of the brush assembly finally comes to rest on the neutral incline 96 when handwheel 100 is rotated.

The movable surface 140 is provided with four neutral paths in the form of inclines 96 and is slidably mounted in grooves 141 and 142 (Fig. 17). The bottom of this plate carries a rack 143 which engages with a pinion 144 so that rotation of the pinion will cause the surface 140 to move in one direction or the other. Pinion 144 is mounted on shaft 145 carrying at the opposite end a chain sprocket wheel 146. This sprocket wheel is linked by a chain 147 to another chain sprocket wheel 148 mounted on shaft 149, which latter carries control knob 150 projecting on the front of the machine. Movement of the control knob 150 will cause the movable surface 140 to move in one direction or the other and thus the neutral paths will also move and the relative positions of the neutral paths to the stylus pins of the switch assemblies will alter. On operation of the handwheel 100 the switch assemblies will move together with their respective dimmers until each switch locates on its respective neutral path and thus a particular color combination is selected.

In order to indicate the position of the movable surface 140 and also the color mixture involved, a scale 160 is provided (Fig. 18). Movement of the control knob will cause pointer needle 161 to move in conjunction with the movable surface 140 and the stopping position of the latter may be judged by the position of needle 161. The top end of the needle is mounted to slide along a thin bar 162 and movement is supplied to it by means of a wire cable 163 which passes over pulleys 164, 165, 166 and 167, Fig. 15, the two ends of the wire cable being attached to opposite ends of the surface 140. The cable is crossed as shown in order that the needle 161 shall move in the same direction as surface 140. A further needle 168, Fig. 18, and scale may be provided at the bottom of scale 162 to indicate the percentage of full light which will be obtained from a specific lighting mixture. Movement of the second needle is obtained by slidably mounting the needle at 169 on a bar 170. This needle 169 is attached to an endless wire cable 171 passing over pulleys 172 and 173 (Fig. 16). Pulley 172 is fastened to shaft 116 so that movement of the control knob 117 moves the sliding fork assemblies and also the needle 168.

It may be preferred to provide overriding manual controls to set each dimmer independently, and in the construction shown in Figs. 15 to 17, four handles 180 are provided each of which is attached to one aluminium plate either 106 or 107. Each handle 180 may carry at its tip a push-button switch 181 to perform the function shown at 47 in the wiring diagram Fig. 7.

It will be appreciated that the handwheel 100 many be continuously rotated by means of a motor, and the speed of rotation thereof will determine the time taken for movement from one predetermined color mixture to another.

It may be desired to provide automatic or semi-automatic operation in accordance with a pre-set lighting plot, and for this purpose the schematic diagram shown in Fig. 19 may be employed. The movable surface 140 is connected by means of a wire cable 200 to a slidable assembly having a pair of contact plates 201 and 202 mounted thereon with an insulated gap 203 between them. The cable 200 will pass over pulleys 204, 205, 206 and 207, and the ends of the cable are fastened to the sides of the movable surface 140. These contact plates 201 and 202 will, therefore, move in exact accordance with surface 140. Contact plates 201 and 202 are connected with relays 208 and 209, each of which may energize electric motor 210 to run in one particular direction, for example, relay 208 may cause motor 210 to run in clockwise direction and relay 209 may cause the motor to run in an anti-clockwise direction. A series of contact plugs are provided, two of which

are shown at 211 and 212. These contact plugs are energized one at a time by means of a rotary step-by-step switch 214 which moves over contact studs 215*a*, 215*b*, and the like. The switch arm is shown in contact with stud 215*b* which is connected to contact plug 211 and is shown as being in contact with contact plate 201. When this plate 201 is energized, relay 209 will operate to cause the motor to run in an anti-clockwise direction and to move the contact plate 201 and 202 leftward until the plug 211 comes into contact with insulating gap 203. As soon as this insulating gap is reached, relay 209 is de-energized and the motor stops, and thus a predetermined lighting combination is set.

It will be seen from Fig. 18 that three slots 216, 217 and 218 are provided into which can be inserted a number of contact plugs which make electrical contact through the front panel of the apparatus with contact plates 201 and 202. The provision of three slots enables plugs to be inserted to provide color combinations which are very close to each other on the color scale without the interference of one plug with the other due to their actual size. Each plug may be connected by an electric cable 213*a*, 213*b* and the like, which latter are connected to the corresponding studs 215*a*, 215*b* and the like on the step-by-step switch. To enable a number of lighting mixtures to be preset in advance, plugs are inserted in the slots in accordance with their order on the step-by-step switch and the switch itself may be operated manually or at a distance electrically by means of a motor or solenoid 219, ratchet 220, and pawl 221, which rotate the switch shaft step-by-step. The supply of electricity to the solenoid coil 219 is attained only when the relay 222 is de-energized. Relay 222 is in series with the common return feed from the magnetic clutch coils and will therefore be energized only when one or more of the clutch coils is in operation and will be de-energized when all the magnetic clutches have reached the position where their associated contact brushes are in their neutral position. Relay 222 will also be de-energized when relay 223 is energized, the latter being connected in the return feed of the electric motor 210. Thus, operation of the solenoid 219 is only possible when the motor 210 is not working and the clutches 212 and 213 are de-energized, that is, when a particular color combination has been selected.

In the case where the shaft 104 is constantly rotating by means of a motor and the lights are in process of being changed, then current will flow on the return feed from the clutch coils through the coil of relay 222, thus keeping open the contact which feeds solenoid coil 219. As soon as all the clutches come to rest, that is when the dimmers have been moved to the desired positions, relay coil 222 will be de-energized and current will now be fed to the coil of solenoid 219, the armature of which will move the rotary switch arm 214 to the next stud 215. Current will now be fed through the plunger associated with this stud in contact with the switch arm 214 to which ever of the contact plates 201 or 202 the plunger is touching, and thence to its associated relay 208 or 209 to the motor 210. Immediately current flows through the electric motor, circuit relay 223 is energized, thus breaking feed to relay 222. Relay 222 is also de-energized since the magnetic clutches are at rest, but the operation of relay 223 ensures that while the motor 210 is in action, the clutches shall remain inoperative. When the motor 210 has caused the contact plates 201 and 202 to move to the position where the insulated gap 203 is in contact with the contact plunger or plug, the supply of electricity to the motor is broken and the contact plate assembly comes to rest. Relay 223 is now de-energized and the return feed to the magnetic clutch coils is completed so that they are now free to operate according to the positions of the switch assemblies on the movable surface. Relay 222 is thus energized and breaks the supply of electricity to the solenoid coil 219 so that the solenoid armature returns by spring action to its "off" position. When the dimmers have all been moved to their new position, all the clutch coils will be de-energized and relay 222 will also be de-energized, thus causing the solenoid to function again and move the rotary switch arm 214 around to the next contact stud. The sequence just described will then be repeated. In this way a series of lighting changes can be obtained automatically as the rotary switch arm 214 is moved from one stud to another.

It will be appreciated that during the time the motor 210 is moving the contact plates 201 and 202 to a new position, the clutch coils will be inoperative owing to relay 223 breaking the return feed. Were this not the case, the dimmers would be moving at the same time that contact plates 201 and 202 were in motion. Further, the rotary switch arm is not moved from one stud to the next stud until a selected lighting mixture has been obtained, but immediately this is the case, then the solenoid is operated and switch arm 214 moves to its new position. There

is, of course, no change in any lighting mixture during the period in which motor 210 is in operation. The motor 225 driving the shaft 104, will, of course, continue to rotate all the time as this has no effect on the dimmers unless any of the magnetic clutch coils is energized.

It will be appreciated that the rotary switch 214 may be operated manually on the machine itself or it may be operated electrically from a distance, as, for example, inserting a push-button switch in the conecntion from solenoid 219 to the relay 222. In the latter case, it will be observed that operation of the solenoid 219 will not be possible until movement of motor 210 is completed and the clutches are de-energized.

It will be understood that one electric motor could be used to provide all the necessary drives, for example, the motor 225 which as diagrammatically shown in Fig. 19 drives shaft 104, could be employed by means of reversible magnetic clutch mechanism to move the contact plates 201 and 202. In this case relays 208 and 209 would energize the clutches for effecting this movement. It may be desired to insert a timing device in the control circuit as shown, for example, at 226, so that regardless of the operation of relays 222 and 223, a fixed period of time will elapse before one lighting mixture merges into another mixture. This timing device may be of any suitable design and may, for example, open and close the circuit at 226 in a predetermined time pattern sequence.

The arrangement shown in Fig. 20 represents a means of providing an adjustable sequence of lighting mixtures. As shown, the neutral path on the movable surface is formed by the sloping ends of adjustable rods 99*a*, 99*b*, 99*c*, etc., which are set in position by means of grub screws. The semi-circular section of these rods allows the stylus to ride up the edge when passing from one rod to the next.

It is preferable that low voltage should be employed for the operation of magnetic clutch coils, contact switch mechanisms, etc. and especially for the contact plugs 211, 212 which are handled by the operators.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. An electric lighting control apparatus for a plurality of light sources comprising a dimmer for each light source, a separate electrically-operated reversible coupling between each dimmer and a single uni-directional operating member, and a circuit breaker in the circuit of each such coupling operating after a preselected extent of operation of the dimmer and driven by the same means as the dimer, wherein each such circuit breaker includes a pair of fixed contacts and a movable contact, the latter being in the circuit of the reversible coupling (the terms "fixed" and "movable" being interchangeable) the movable contact being connected for progressive movement with progressive movement of the movable element of the dimmer and passing through a neutral position when moving from one fixed contact (for a drive in one direction) to the other fixed contact (for a drive in the other direction).

2. An apparatus according to Claim 1, wherein the coupling of the operating member to the drive to the movable contact (and the dimmer) is such as to allow a selective coupling being established at any point in the path of the moving contact, so as to vary the extent or time period of movement before the neutral position is reached.

3. An apparatus according to Claim 1 or 2 having means for varying the total time period for the complete cycle of change, without varying the relative time values for the individual changes.

4. An apparatus according to Claim 3, wherein the movable contacts are extensible oscillating members and wherein the fixed contacts are capable of advancement and retraction towards and away from the centre of oscillation so as to vary the extent of sliding contact for a given angular displacement.

5. An apparatus according to Claim 1, 2, 3 or 4 embodying for each set of contacts a pair of spaced parallel plates and a feeler movable transversely over and between those plates, such feeler when in contact with one or other plate causing electrical contact for a corresponding drive in one or other direction and when between the plates preventing any drive.

6. An apparatus according to Claim 5 wherein said plates are themselves the fixed contacts and the feeler is the movable contact.

7. An apparatus according to Claim 1, 2, 3 or 4 embodying for each set of contacts a cam plate with bevelled edge and a feeler movable transversely over such edge on to and from said plate, the feeler being carried by the movable contact of the circuit breaker and holding that contact in a neutral position when on said edge, and moving it against the respective fixed contact when on and off the plate.

8. An apparatus according to Claim 1, 2, 3 or 4, wherein the movement imparted to the movable contact by the drive to the

dimmer causes such contact to slide over one or other of the fixed contacts until it arrives at the neutral point.

9. An apparatus according to Claims 1, 2, 3, or 4, wherein the drive to the dimmer imparts movement to the fixed and moving contacts as a whole, and cam means is employed to cause the fixed and moving contacts to separate when the neutral position is reached and to re-engage when the neutral position is left.

10. An apparatus according to any of the preceding Claims, wherein the several fixed contacts may be displaceable laterally, i.e. at an angle to the direction of movement of the moving contacts over them, and thereby be presented to the moving contacts (or some of them) in new relationship so as to reach the neutral points in shorter or longer times.

11. An apparatus according to Claim 10, wherein the moving contacts slide over the respective fixed contacts, and wherein the fixed contacts are of varying widths at different points in their length, i.e. in the direction of lateral displacement, so as to vary the position of the neutral point.

12. An apparatus according to Claim 10, wherein cam means is employed, as claimed in Claim 9, and is of a varying shape in the direction of displacement of the contacts.

13. An apparatus according to Claim 12, modified in that the cams are displaceable in relation to the contacts.

14. An apparatus according to Claim 10, characterised by a plurality of shaped contact plates, arranged in pairs in generally-parallel disposition, with the shaped edges mating with each other but at a little distance apart, contact with one plate driving the dimmer in one direction and contact with the other plate driving the dimmer in the other direction, a corresponding plurality of contacts movable over the said plates and across the space between them, and means for moving the plates in the direction of their parallel disposition to present varying parts of the shapes to the moving contacts.

15. An apparatus according to Claim 14, wherein the shaped contact plates are mounted on a common carrier slidable in guides.

16. An apparatus according to Claim 15, and having oscillatory moving contacts and advancing and retractable fixed contacts as claimed in Claim 4, wherein the said guides are themselves movable (with the said carrier) towards and away from the centres about which the radial members oscillate.

17. An apparatus according to Claim 9 having a plurality of shaped cams, in generally-parallel disposition, a corresponding plurality of cam followers movable across the cams, the cams being displaceable together in the direction of their parallel disposition to present varying parts of the shapes to the followers, and sets of fixed and movable contacts.

18. An electric lighting control apparatus for a plurality of light sources comprising a dimmer for each such light source, a time switch (as herein defined) for each dimmer for progressively bringing the respective dimers to the "full-out" or to a "full-on" position, separate reversible electric coupling means between each dimmer (with its associated time switch) and a single constant-speed operating member, and means for engaging the respective couplings at any selected time period prior to arrival at said "full-out" and "full-on" positions, each such time switch including two fixed and one moving contacts the latter receiving progressive movement from the drive to the dimmer and passing through a neutral point when moving from one fixed contact for (a drive in one direction) to the other, (for a drive in the opposite direction) at which neutral point it interrupts the coupling means.

19. An apparatus according to Claim 1 or 18 comprising a co-axial series of rotary dimmers, a series of rotating driving means therefor, each such means including oppositely rotated gears, and means for selectively coupling either of said gears to an operating member rotating in one direction only.

20. An apparatus according to Claim 19, wherein the several oppositely rotating gears are mounted on a common shaft constituting the operating member, each set of oppositely rotating gears including two opposed bevel gears one of which is secured to the shaft and the other not, and both meshing with a common intermediate bevel gear on a fixed axis.

21. An apparatus according to Claim 19 or 20, wherein rotating means for the dimmers includes a member movable with either of the oppositely rotated gears and having two electro-magnetic means for selective coupling to those gears, one such means being in the circuit of one fixed contact and the other in the circuit of the other fixed contact.

22. An apparatus according to Claim 21, wherein the said movable member includes a handle for manual operation of the appropriate dimmer, and such handle carries a switch for temporary release of the electro-magnetic coupling during such manual operation.

23. An apparatus according to Claim 1 or 18, comprising a co-axial series of rotary dimmers, a series of rotating driv-

ing means therefor, each such means including a pair of pulleys fixed to the rotary member of the dimmer, open and crossed belts for driving the respective pulleys, and means for selectively driving either of said belts from the uni-directional operating member.

24. An apparatus according to Claim 23, wherein the open and crossed belts engage driving pulleys loosely mounted on a common shaft constituting the operating member, with clutch means for selectively coupling either of those pulleys to the shaft at will.

25. An apparatus according to Claim 24, wherein between each pair of driving pulleys is a disc fixed to the shaft, with magnetic clutch means to operate between the respective pulleys and the disc.

26. An apparatus according to any of the preceding Claims comprising a coaxial series of rotary dimmers, a corresponding series of rocking switch arms, intermediate mechanism for transmitting motion from each dimmer to the respective switch arm, a pair of fixed contacts for each switch arm and a movable contact on or in each arm, means for selective pre-setting of the movable contact on one or other of the fixed contacts, and driving means whereby progressive movement of the switch arm, due to rotation of the dimmer brings the movable contact to a neutral position between the fixed contacts.

27. An apparatus according to Claim 26, wherein the fixed contacts comprise pairs of flat contact plates with shaped edges defining a neutral line between them, wherein the several plates are mounted for simultaneous movement across the path of the moving contacts, to present new positions of the neutral line to the moving contact, and wherein the several plates are movable towards and away from the axis of rotation of the switch arms to vary the extent of movement of the moving contacts over them.

28. An apparatus according to Claim 25, wherein the several pairs of shaped plates are adjustable relatively to each other to vary the relative positions of the said neutral lines.

29. An apparatus according to Claim 27 or 28, wherein the switch arm itself constitutes the moving contact, and wherein the arm is disposed normal to the flat plates and on the neutral line when the dimmer is in the " full-out " position.

30. An apparatus according to Claim 26, wherein the switch arm has a part which rides on a stepped surface, the step being inclined and constituting a cam of varying shape along its length, the movable contact being in the neutral position when the said part is midway up the step.

31. An apparatus according to Claim 30, wherein each dimmer has a rotary cam operating a rocking lever, wherein a sliding rod moving over the said stepped surface carries the part which rides on such surface, wherein a connecting link pivoted to such rod engages the said lever arm so that the rotation of the cam reciprocates the sliding rod, and wherein the connection between the link and the lever arm is adjustable to vary the stroke of the sliding rod.

32. An apparatus according to Claim 30 or 31, wherein the stepped surface is displaceable to bring new positions of the cam step into the path of the said part carried by the sliding rod.

33. An electric lighting control apparatus according to Claim 1, wherein there is an interchangeable pattern determining the sequence of control, each pattern including shaped neutral lines (one for each circuit breaker) on which the circuit breakers are open, with means for displacing those lines in the general direction of their length so as to bring different parts of them into operative association with the contacts of the circuit breaker.

34. An apparatus according to Claim 33, wherein the said pattern comprises pairs of flat contact plates with shaped edges defining the neutral line between them, and adapted to be moved across the respective paths of sliding contacts slidable from one plate to the other of the respective pairs.

35. An apparatus according to Claim 33, wherein the said pattern comprises a series of shaped cam steps on a stepped plate, adapted to be moved across the path of a number of cam followers which hold the respective circuit breakers open when midway up the step.

36. An apparatus according to Claim 10 or 33, or Claim 10 with any later Claim appendant thereto, wherein the lateral displacement of the fixed contacts correspondingly displaces other contacts having a neutral point between them, and wherein contact pins in pre-selected positions can be brought into circuit with those other contacts individually to energise a motor for causing such lateral displacement until the individual contact pin reaches said neutral point.

37. An apparatus according to Claim 36, comprising a step-by-step switch, operated electro-magnetically whenever all the moving contacts in the dimmer drives have reached their neutral positions and when, at the same time, the motor for causing the lateral displacement of the fixed contacts (and said other contacts) is idle, the electrical connection of

such switch with the next contact pin both energising the motor to effect the lateral displacement and assisting the step-by-step switch.

38. An apparatus according to Claim 37, comprising a solenoid-operated step-by-step switch, rotatable over a series of contacts each of which may be connected with one of said contact pins, a relay-operated switch in the circuit to such solenoid, the coil of the relay being in the common return from magnetic clutches in the several driving means for the dimmers, a further relay-operated switch in such common return, the relay coil of which is in circuit with the motor which causes the lateral displacement, and relay coils electrically connected respectively to said other displaceable contacts, the armatures of the relays, when the respective coils are energised, energising the motor.

39. An apparatus according to Claim 38, having also a clock-controlled switch to control the time of operation of the said solenoid.

40. An apparatus according to Claim 1 or 18, constructed and adapted to operate substantially according to the example herein described with reference to and as illustrated in Figures 1 to 7 of the drawings accompanying the Provisional Specification, or as modified according to Figure 8 or Figures 9 and 10 of those drawings, or as modified according to Figures 11, 12 or 13 of the accompanying drawings.

41. An apparatus according to Claim 1 or 18, constructed and adapted to operate substantially according to the example herein described with reference to and as illustrated in Figures 15 to 17 of the accompanying drawings, or as modified according to Figure 20 of the same drawings.

Dated this 26th day of May, 1948.

ERIC POTTER AND CLARKSON,
Chartered Patent Agents,
Nottingham and London.

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FIG 1.

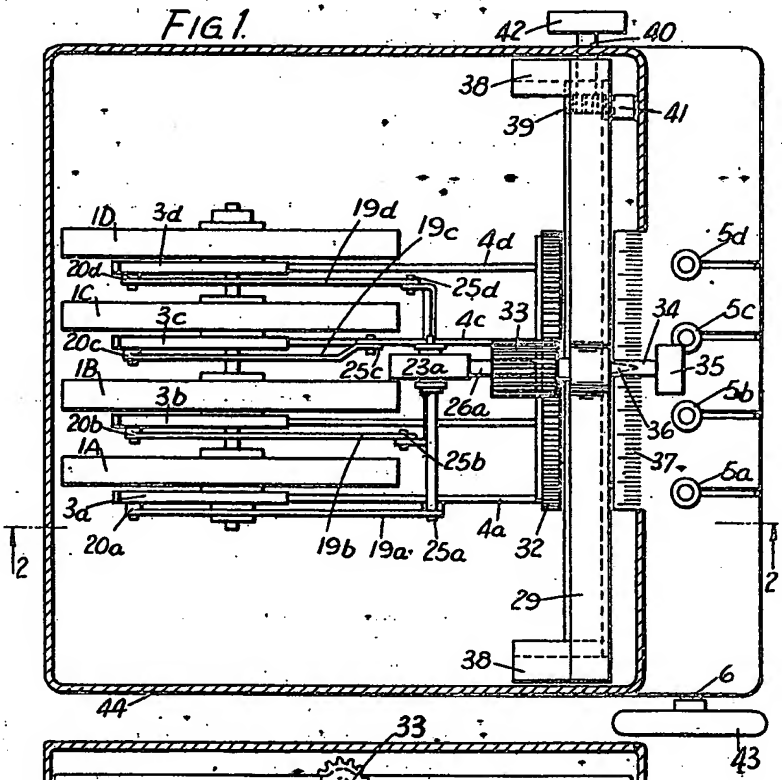
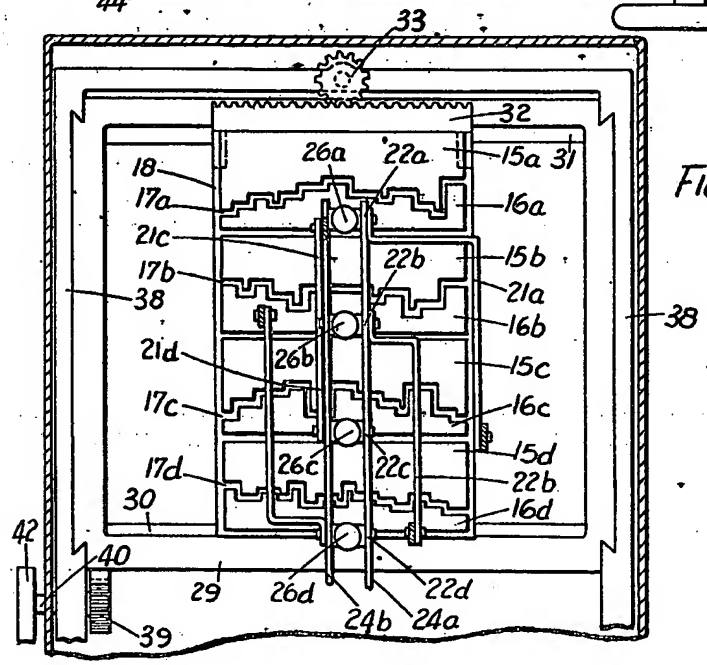


FIG 4.



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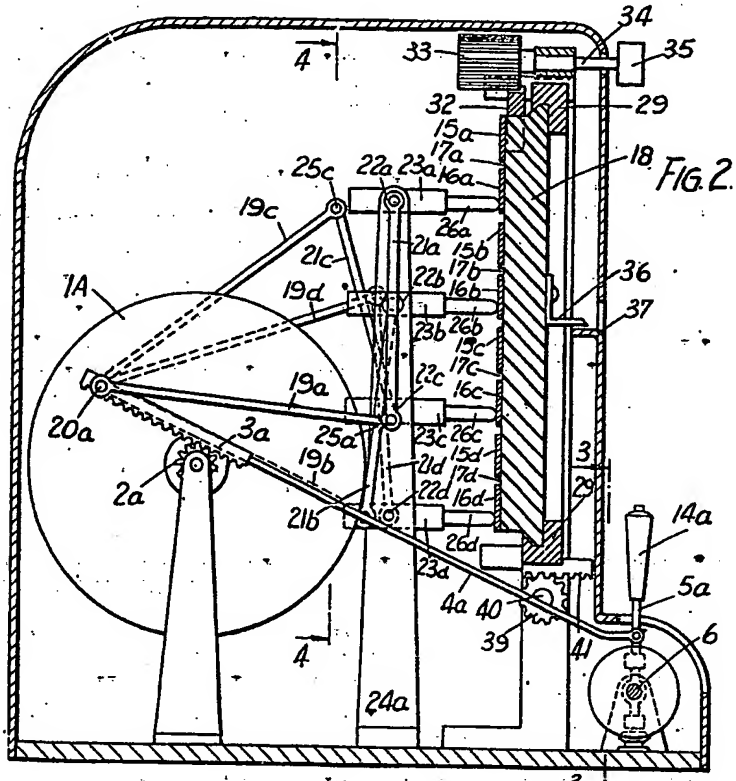


FIG. 2.

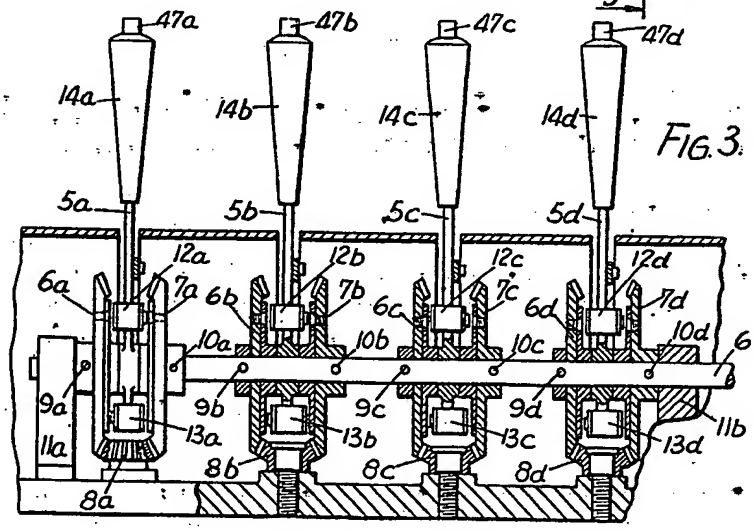


FIG. 3.

FIG. 5.

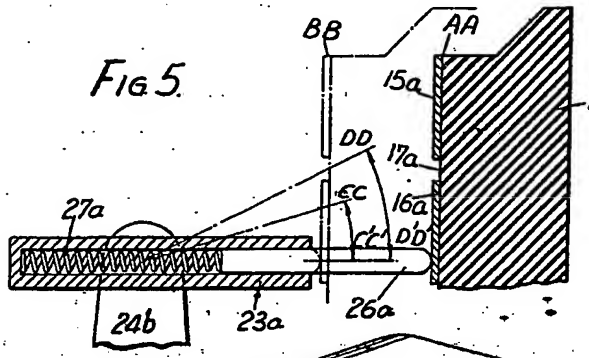


FIG. 9.

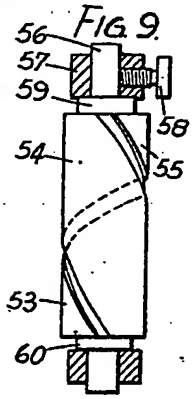


FIG. 6.

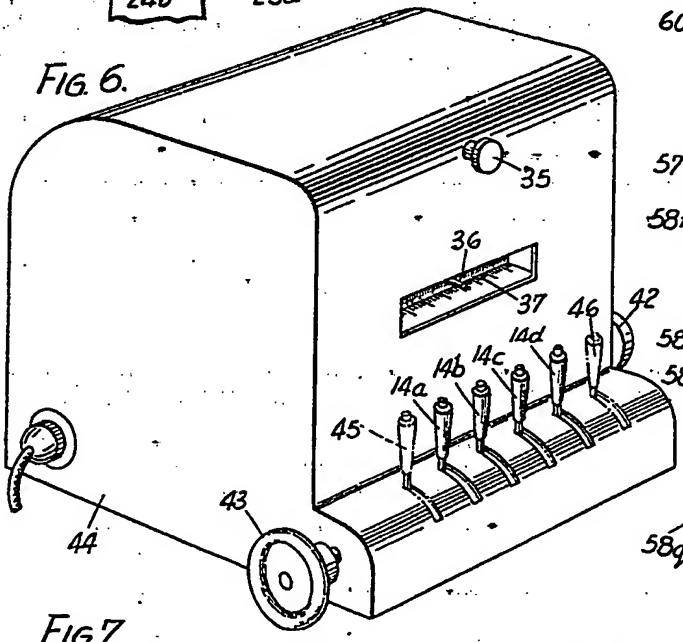
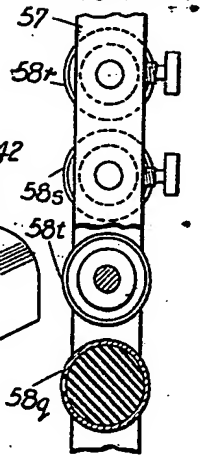


FIG. 10.



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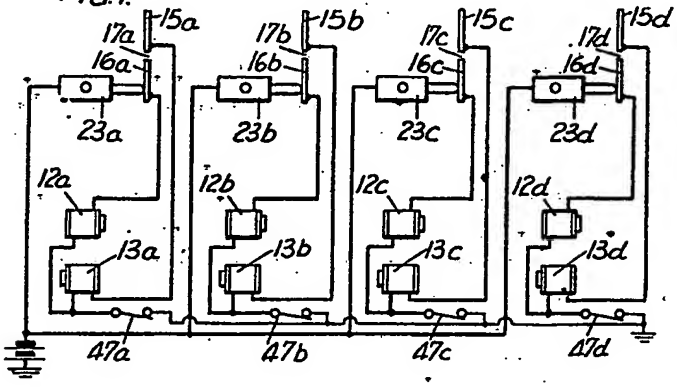
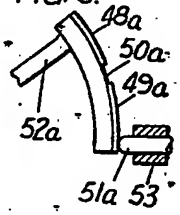


FIG. 8.



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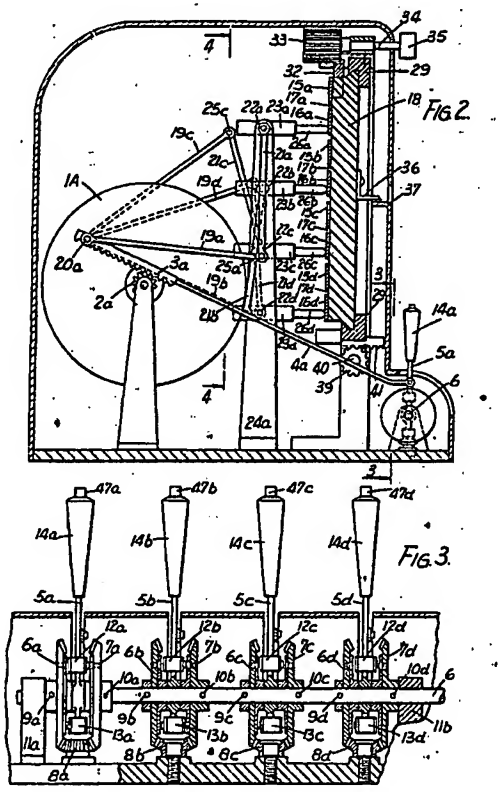
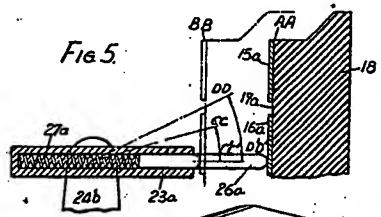


FIG. 2.

FIG. 3.

SHEET 3



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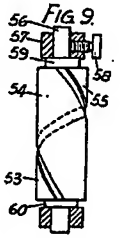

FIG. 9.

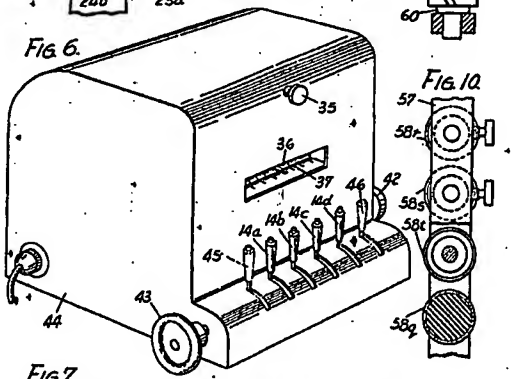

FIG. 6.

FIG. 10.

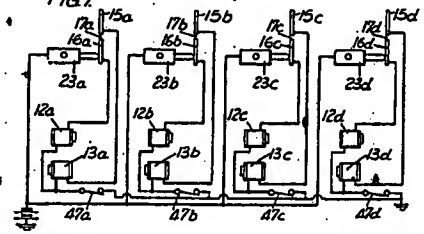

FIG. 7.

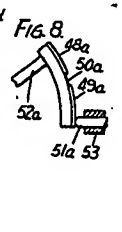

FIG. 8.

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661,083 COMPLETE SPECIFICATION 5 SHEETS
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Fig. 11

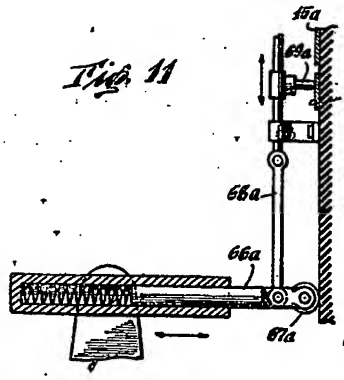


Fig. 12

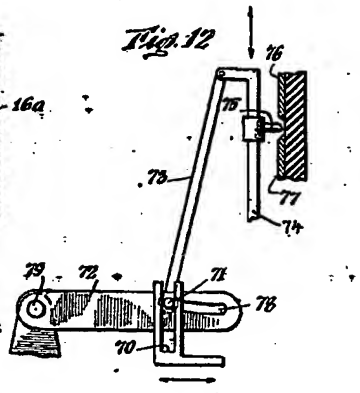


Fig. 13

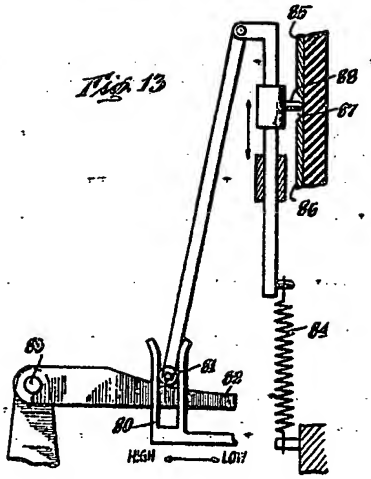
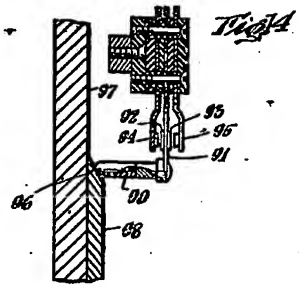


Fig. 14



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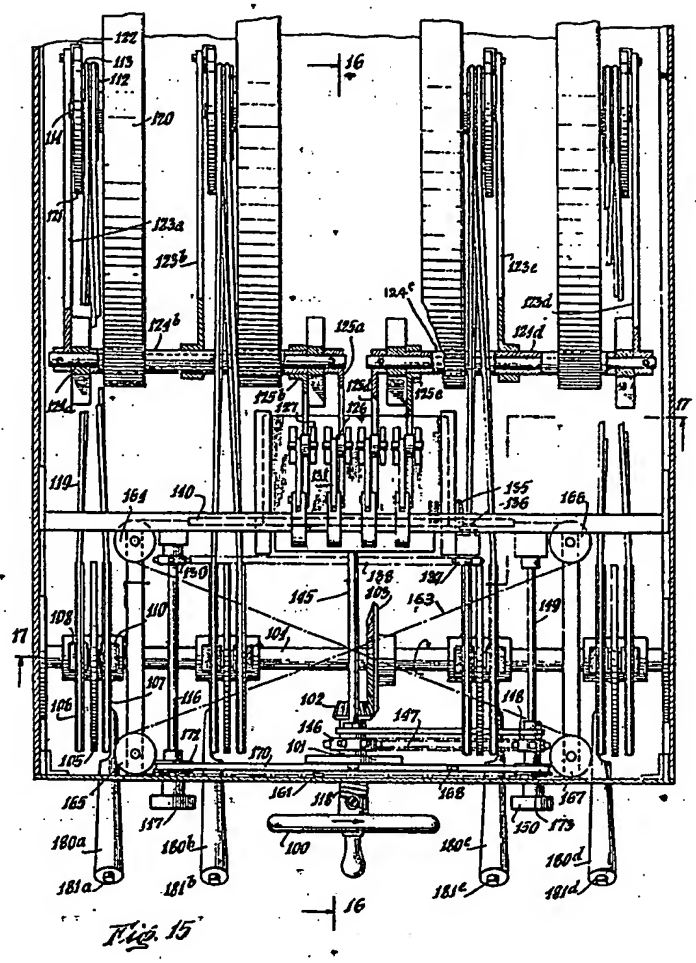

Fig. 15

5 SHEETS

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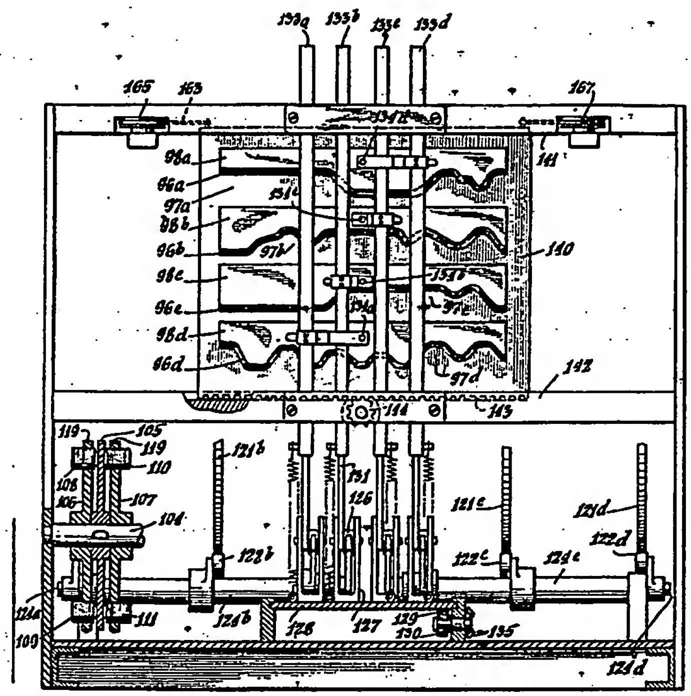

Fig. 17

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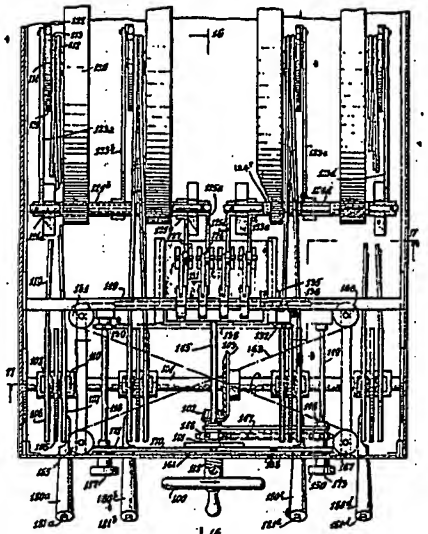

Fig. 15

SHEET 4

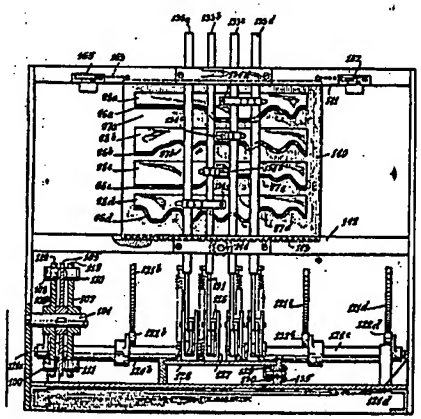

Fig. 17

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Fig. 20

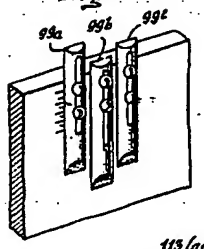


Fig. 16

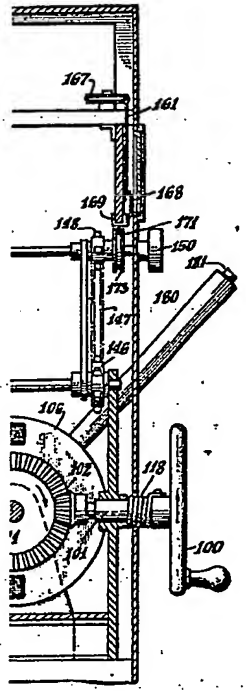
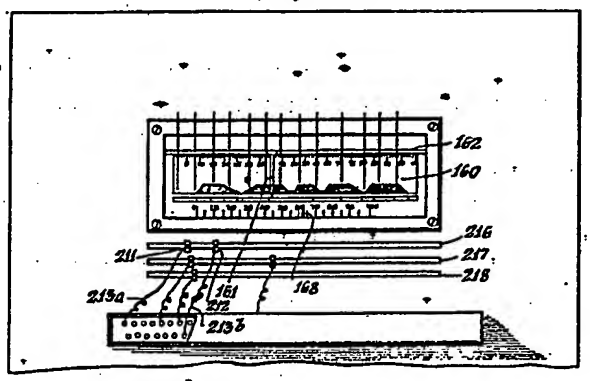


Fig. 18



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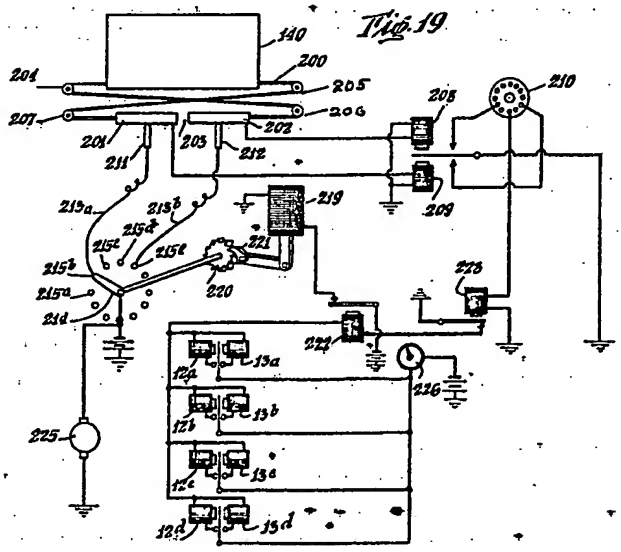

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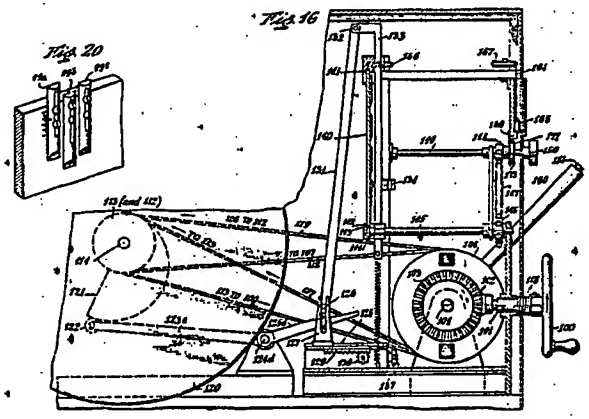

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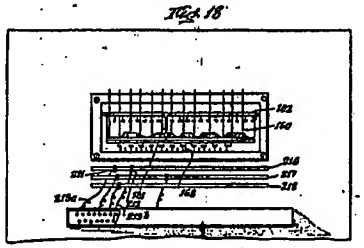

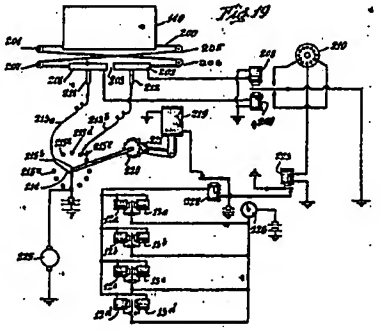

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